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"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH

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ERRATUM

P. 624, col. 2, l. 13, *for* "Magnitudes" *read* "Magnetism."

Joseph Lister

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"*To the solid ground
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THURSDAY, MAY 7, 1896.

SCIENTIFIC WORTHIES.

XXIX.—SIR JOSEPH LISTER.

I HAVE responded with great pleasure to the honourable request that I should give some sketch, for the readers of NATURE, of Sir Joseph Lister's scientific eminence. As a *confrère* I know him not merely from his prominent scientific renown, but also as a friend, and I too, like other German surgeons, have sought out the founder of modern surgery in his London hospital and, filled with gratitude, have laid my homage at his feet. Lister was many years ago in Leipzig, and I shall never forget the *fête* we then organised in his honour. How we cheered him on that evening, professors and students, old and young! For was it not in Germany first, rather than in England, that his scientific works met with their earliest recognition and general appreciation! Lister was in his day a prophet, and proclaimed a new doctrine for the healing of wounds. And how often prophets fail to find in their own fatherland, especially in the early stages of their activity, the recognition they so well deserve!

Lister's immortal life-work is his antiseptic method of operating and of treating wounds, and it constitutes the greatest advance which surgery has ever made. It is true that operational technique had reached a previously undreamt of development after chloroform and ether had banished pain in 1846 and 1847. But the surgery of those days wanted one thing more—certainty of a successful issue to its operations. Surgeons were still helpless in fighting the ever-present septicæmic infection of wounds, which snatched to the grave so many patients and injured sufferers. Were they but able to circumvent this deadly infection of the bodily fluids, the blood and the lymph, and could they but secure as a rule and not the exception the reactionless healing of wounds without inflammation and suppuration, then would surgery as an art be diverted into new channels, and strive for the goal of final perfection. It was exactly Lister's antiseptic method of operating and treating wounds which first showed the way to the attainment of that healing "by first intention," which had been a subject of discussion for centuries, and of that certain avoidance of traumatic infection of which the general nature was so well known. And now every day we note, with joyful and grateful hearts, and with hitherto unknown feelings of innermost satisfaction, the splendid outcome of this the greatest acquisition of modern surgery. Lister did not create antiseptic surgery suddenly, or without means to his hand, for the path was already smoothed with invaluable scientific facts from the domains of physiology, chemistry, botany, and general experimental pathology. Schulze, Schwann, Helmholtz, Schroeder, Dusch, and, above all, Pasteur had proved that all fermentations and putrefactions are due to organised germs, to those ever-present micro-organisms the schizomycetes or bacteria. This fact had at first received only scant attention, but in Lister's hands its importance for the development of surgery was immense. He began his experiments on the treatment of wounds in the Glasgow Infirmary, somewhere about the year 1864, and characterised his method as "antiseptic," since it was consciously and confidently aimed at the avoidance of all putrefactive changes in the parts affected. In his views as to the nature of traumatic infection, Lister took his stand on the basis of those scientific facts regarding fermentation and putrefaction which, as already stated, had been thoroughly established. He said to himself, "It is not the mere air as such that is antagonistic to the process of healing a wound, but rather those organised germs which are so universally disseminated in the world around us: bacteria are the cause of all inflammation and suppuration, and hence of septicæmia." In this persuasion he directly attacked the problem of how not only to exclude bacteria from entering a wound, but also to destroy by disinfectants those already present, and to stay their further development. Lister selected carbolic acid as a disinfectant. Now it is true that even before his time various antiseptics, and among these carbolic acid, had been employed in bandaging; but to Lister alone is due the unending merit of methodically and confidently working out the detailed technique of antiseptic operating

and bandaging. Like many a new invention, Lister's was also at first incomplete, and was attacked from many sides, partly as to the principles on which it was based, and partly on the grounds of the somewhat complicated manipulations it involved. But, firmly persuaded of the correctness of his theoretical views, he went on steadily developing the details of his antiseptic methods, at first in Glasgow, and later in Edinburgh and London. He endeavoured to prevent the entrance of bacteria by careful disinfection of every object which comes into direct or indirect contact with the wound, more especially of the operational area on the patient, of the hands of the surgeon and his assistants, of the instruments, sponges and absorbents. To the same end he introduced the use of carbolic "spray" during the operation itself and each subsequent change of dressings, and by his ingeniously devised carbolised gauze protected the wounds from further infection. Injuries or wounds already infected were methodically disinfected by 2·5 to 5·0 per cent. solution of carbolic acid. Lister's typical dressing, as it first came into more general use, was applied as follows. A layer of waterproof silk, the "protective," was placed over the wound to shield it from the direct action of the irritant substances (carbolic acid, paraffin) in the antiseptic dressing materials; over this came some eight or more layers of carbolised gauze or muslin, and between the outer two of these a sheet of gutta-percha tissue. The whole was then securely bound round with carbolised gauze so as to effect as far as possible an air-tight enclosure of the wound. This Listerian bandage, as it soon came to be called, was both applied and changed under a continuous carbolic spray.

The results which followed the application of Lister's methods, as used not only for operational but accidental injuries, were at that time—1873 to 1875—simply astounding. We read with the deepest satisfaction the surgical reports of those early days of the more general employment of Lister's antiseptic devices, and find them inspired with proud feelings as of a mighty victory finally won after prolonged and grievous defeats. No such curative results had ever been attained up to that time. In the self-same hospitals in which till then septicæmic infection had kept the upper hand, the best results were henceforth obtained, and the once-dreaded wound-fevers became more and more a rarity. Operations were now successful which had previously been nearly always fatal. The ever-advancing scientific investigations of traumatic septicæmia, more particularly as carried on by Koch and his pupils, and dealing with its origin and nature from the point of view of the deleterious action of bacteria, gave more and more a sound scientific basis for Lister's antiseptic method and removed all doubts as to the correctness of his views. Most convincing proof of the part played by the bacteria was provided by the inoculation of animals with pure cultures of these various organisms; and it was exactly and solely these experiments that proved the all-important fact that in reality all the troubles and dangers which threaten a wound, and hence the life of a patient, are determined by the deadly action of bacteria. This is the fact on which modern surgical methods are based. And in the face of this, people are still found who contest the utility of experiments on animals! It would be well if the opponents of vivisection could correctly picture to themselves the blessings for which the human race has to thank Lister's antiseptic method, and their relation to animal experiment. Did they but realise how many human lives are now saved in comparison with the past, surely they would be compelled to admit the use of vivisection. And, in the future also, scientific medicine imperatively demands experiments on animals for its investigations in the interest of mankind.

When once surgeons had learnt complete mastery of Listerian method, the results they obtained were progressively better. With the help of antiseptic precautions they succeeded in operations on which they would previously have never dared to venture. With these splendid results before their eyes, even those scattered opponents of the system who had at its inception raised their voice against it became silent, for they could no longer blind themselves to the conviction that a new and brilliant era was opening up for surgery.

After Lister's antiseptic method had become the common property of all surgeons, it was progressively improved and simplified, more especially in Germany. One of the most important facts for its further development was the proof that wound infections are chiefly due solely to actual contact with already infected objects, and that any infection by the entry of microbes from the neighbouring air rarely, if ever, occurs. Moreover, it was shown with increasing certainty of proof that under normal conditions the blood, lymph and tissues of healthy animals are free from bacteria. Upon these important facts the conclusion was based that it is unnecessary to disinfect a fresh and uninfected wound, such as a surgical incision, so long as every object which comes into direct or indirect contact with the wound is truly and perfectly sterilised or aseptic in accordance with Listerian requirements. Hence nowadays operations are performed with almost painfully precise sterilisation of every object or instrument employed, as Lister first taught us to do, while at the same time we limit as far as possible the action of irritant antiseptics, such as carbolic acid, and even advantageously use none at all, operating with as little fluid as possible. So far as it may be necessary the fluid now employed is a sterilised solution of common salt, or else sterilised water. In the place, then, of carrying out our operations under the former strictly antiseptic precautions, we now operate aseptically. But the fundamental idea on which Lister's antiseptic method was based has remained unchanged, and will always be the same. We deal with it in internal operations merely in a slightly different way, in so far as we omit the disinfection of wounds with such substances as carbolic acid or corrosive sublimate, regarding their action as unnecessary or even injurious. But all our precautions against traumatic infection are taken with the most minute care. The operational area on the patient is carefully disinfected in accordance with Lister's instructions, and is surrounded with aseptic linen compresses sterilised in steam at 100°–130° C. We employ exact and definite methods to free our hands from microbes, and the instruments are sterilised by boiling in 1 per cent. solution of sodium carbonate. All bandages and the outer garments we wear are made aseptic by prolonged exposure to steam at 100°–130° C. in a specially

constructed apparatus; and so, also, in respect of all else. Steam thus provides us nowadays with non-irritant bandaging materials free from germs with even greater certainty than did their earlier impregnation with antiseptic substances, for bacteria may always be found after the lapse of time in dry bandages which have been dipped in either carbolic acid or corrosive sublimate. Instead of sponges we now use muslin absorbents sterilised by steam, and these, like every other fragment of bandaging material, are burnt after being used but once. In short, the technique of modern surgery is based on Lister's method, and takes for its watchword "asepsis without the use of antiseptics." Antisepsis has given place to asepsis, but the latter is just as surely based on the ground first broken by Lister.

The results of operations carried out under aseptic precautions are magnificent. Surgery now celebrates its greatest triumphs in dealing with the skull and cranial cavity, with the brain, spinal column and spinal canal, with the thoracic and abdominal viscera, with bones and joints, with tendons and nerves. For accidental injuries, or wounds which are already infected, the older antiseptics are still employed, although we know that the complete disinfection of a festering wound is most difficult, nay almost impossible, for we cannot sufficiently reach the microbes lurking in the substance of the tissues. What we chiefly look to in this case is the efficient removal of the purulent secretion from the wound, securing this by free incisions and drainage.

Sir Joseph Lister must indeed experience a glorious feeling of deepest satisfaction when he surveys the labours of his life. His work is accomplished and brought to an incomparable conclusion. He has conquered and attained his object. When we but compare the surgery of thirty years ago, before Lister appeared on the scene, with that of to-day, what a change we see! We can scarcely carry ourselves back in imagination to the pre-antiseptic days of surgery, but each one who has known the older state of things from personal experience, cannot fail to realise with fuller understanding and livelier joy how great a blessing Lister is to suffering humanity. Formerly the healing of injuries or wounds after an operation lay by no means certainly in the hands of the surgeon. In many hospitals the conditions which existed before the advent of Lister were simply incredible. Innumerable victims were snatched away to death by traumatic infections. And how do things stand now? To-day, thanks to Lister, we can heal the most grievous injuries and carry out the most difficult operations without inflammation, suppuration, or fever. We have now a firmly grounded confidence in our surgical art, and our patients, too, trust to the capabilities of modern surgery, for they know that we can heal the wounds we make. The possibility now afforded by Listerian method of preserving and giving back health and life to our patients has led to the growth among the surgeons of every nation of a pride in their professional activities, which finds its expression in the form of active theoretical and practical work. Science and art are international. The doctors of all nations are fighting shoulder to shoulder for the welfare of suffering humanity, and we Germans recognise without a suspicion of jealousy that the sun of modern surgery first rose in the person of Sir Joseph Lister and in England. The word surgery in its origin signifies a handicraft; but that which was thus manual at first has become an art and a science which has, thanks above all to Lister, raised itself with impetuous and surprising speed in the last twenty years to a previously unknown height of development. Modern surgery no longer stops short at the exterior, but has gone even deeper, and now includes within the sphere of its activity every organ of the human body without exception. And for this mankind is indebted in the first place to Sir Joseph Lister. As far as there is an earthly immortality it must be his, for as long as ever surgery is scientifically discussed his name cannot fail to be mentioned.

H. Tillmanns.

Sir Joseph Lister is not, as has been often stated, a Scotchman. He was born at Upton, in Essex, which was then a pretty suburban village, though it has long since been completely swallowed up in the metropolis, and here the greater part of his early life was spent. His father, Joseph Jackson Lister, was a man of rare ability, who devoted the intervals of business to scientific pursuits. He was a Fellow of the Royal Society, and is best known for his work on the improvement of the microscope, which is embodied in a paper in the *Philosophical Transactions* for 1831, "On some Properties in Achromatic Object-glasses applicable to the Microscope." Other papers of his appeared in the *Philosophical Transactions*, one of which was written in conjunction with the well-known Dr. Hodgkin, who belonged, like him, to the Society of Friends. They were the first to describe the tendency of the red corpuscles of the blood to arrange themselves in rouleaux.

Sir Joseph Lister was thus early imbued with scientific tastes, and learned by example, if he did not inherit by descent, the habit of accurate observation and relentless logic; in short, that capacity for taking pains which has been in a special manner the characteristic feature of his genius. He was educated at a private Quaker school at Tottenham, which numbered amongst its pupils at about the same time the late Mr. William Edward Forster and Dr. Wilson Fox; and afterwards he became a student at University College, London, from which he graduated B.A. at the University of London in 1847. He then entered upon his medical studies at University College, and here he came under the influence of Sharpey, which possibly had something to do with turning his attention, in the first place, to the study of physiology. His first publications appeared in the year 1853, whilst he was still a student, "On the Muscular Tissue of the Skin" and, "On the Contractile Tissue of the Iris." He began his surgical studies just at the close of the career of Liston, one of the last of the brilliant and rapid operators of the last generation; and he was one of the first house surgeons to Mr.—now Sir John—Erichsen. After a very distinguished career at the hospital and the University, where he graduated M.B. in 1852, he went to Edinburgh, to see the surgical practice there. Here he was closely associated with, and soon became deeply attached to the late Prof. Syme, whose daughter he subsequently married. At first he was Mr. Syme's house surgeon, but before long he was appointed Assistant Surgeon to the Royal Infirmary, and Extra-Academical Lecturer on

Surgery, in which capacity he soon attracted to himself a devoted band of admirers. Whilst in Edinburgh he not only published notes of Mr. Syme's cases, but continued to pursue his physiological and pathological researches. Between 1857 and 1860 several papers appeared on a variety of kindred matters, of which the most important are those dealing with the subject of inflammation and that of coagulation of the blood. In 1857 his paper "On the Early Stages of Inflammation" was read before the Royal Society, preceded by two others, one being "An Inquiry regarding the Parts of the Nervous System which regulate the Contractions of the Arteries," and the other "On the Cutaneous Pigmentary System of the Frog." This work remains up to the present time one of the most important contributions to the subject. Various observations on the coagulation of the blood, a much-debated matter at that time, culminated in the Croonian Lecture of 1862, which excited great interest, upsetting as it did most of the accepted notions, and forming the groundwork of much of our modern teaching on the subject. In 1860 Lister was appointed Regius Professor of Surgery in the University of Glasgow, and it was there, surrounded by the typical surgery of the old *régime*, and shocked by the prevalence and fatality of the so-called hospital diseases, that his work in connection with antiseptic surgery was begun. Those, however, who have studied his various writings will not fail to observe how his physiological observations were the precursors of his pathological studies, and these again, as he traced first the appearances and then the causes of inflammation, led on step by step to the association in his mind of the inflammation occurring in open wounds with the action of micro-organisms introduced from without, and so to the crowning performance by which his name will be principally handed down to posterity. He always acknowledged the influence of Pasteur's work on the evolution of his ideas, as has been pointed out by Prof. Tillmanns.

His writings since that time have been chiefly devoted to one branch or another of the subject of the germ theory of disease. They consist of articles scattered about amongst various periodicals, so that it would be a difficult matter to produce a complete list of them. Some are elaborate investigations into the processes of fermentation and the life-history of certain micro-organisms, most of which were carried out before the introduction of the plan of cultivating these low forms of life upon solid media, and therefore involved far greater difficulties than are met with at the present day; others are treatises on the bearing of bacteriology upon surgical treatment.

The controversy which was raised on the first promulgation of his views was very warm, and it took a strangely long time before their acceptance in this country was by any means general. To many educated under the old system, it seemed hard to appreciate, first that there was anything new in the antiseptic system at all, and secondly that the modifications of the details of the treatment in the course of its evolution, did not imply a recession from the principles upon which it was founded. It was a stumbling-block to some that, as knowledge advanced, and as it became recognised that the atmosphere was not, as it had been at first supposed, charged with innumerable particles bearing the germs of putrefaction—the details of the treatment became simpler. By an unlucky chance, the term "spray-and-gauze-treatment" had by some been substituted for the "antiseptic treatment"; and when our German *confrères* started the watchword "fort mit dem spray," and it was enthusiastically taken up here, it was assumed that Lister had shifted his ground. The assumption was, it need not be said, absolutely without foundation. The earliest antiseptic dressings were much more cumbrous than those mentioned by Prof. Tillmanns. The first attempts consisted in making an antiseptic crust of blood and pure carbolic acid which was protected by a sheet of block tin, then followed the use of carbolic acid and oil, and then that of a layer of putty made with carbolic acid; after this came a plaister made of shellac and carbolic acid, and all these preceded the carbolic acid gauze, whilst the use of the spray was for a long time unknown. Lister was always aiming at simplifying the details of the treatment; none regretted more than he did its complications, and no one rejoiced more than he, when he found that he could give up the use of the spray with a clear conscience. His idea, in fact, has always been to make an external wound behave as much like a subcutaneous injury as possible by the simplest practicable means.

The antiseptic system was fairly launched about 1867, and in the year 1869 Lister was appointed successor to his father-in-law in the chair of Clinical Surgery at Edinburgh; and here he continued the elaboration of his system, lecturing to large and enthusiastic classes, numerically much greater than any which can be met with in London, whilst his clinique acquired a world-wide reputation.

In 1877, on the death of Sir William Ferguson, he was appointed Professor of Clinical Surgery at King's College, London, a position which he held till three years ago.

No reference has hitherto been made to the many improvements and modifications in surgical practice with which the name of Lister is associated; but though they may not be of much interest to the general reader, it would not be right to pass them over altogether.

Long before Esmarch introduced his method of bloodless operation on the limbs, Lister was in the habit of obtaining the same result in a less objectionable way, by simply elevating the limb, which, as he has shown, empties itself not merely mechanically, but by means of an active contraction of the arteries consequent upon the altered position. He also was the inventor of a tourniquet for compressing the abdominal aorta, thus diminishing hæmorrhage in operations in the neighbourhood of the hip-joint. He has introduced several new operations to the profession, notably an amputation which bears his name, and an operation for excision of the wrist, which, although it is now almost superseded, was for a long time looked upon as the orthodox method of treatment. He was the first to undertake osteotomy for the purpose of rectifying deformity of the limbs, and the first to advocate a more complete method of operating on cancer of the breast, than had been practised by his predecessors. Another advance associated with his name is that of treating fractures of the patella and other bones communicating with joints, by means of open incisions and wiring, a procedure which, before the introduction of

antiseptic surgery, would have been obviously unjustifiable.

We have hitherto dwelt chiefly upon his scientific work, but such facts as those just mentioned serve to show how largely he has devoted himself to, and how much he has advanced, the practical side of his profession.

It seems almost unnecessary to refer to a list of his honours, which is a very long one, including that of LL.D. Edinburgh, 1878, Hon. M.D. Dublin, 1879, LL.D. Glasgow, 1879, D.C.L. Oxon, and LL.D. Cambridge, 1880. He is Surgeon-Extraordinary to the Queen, and Knight of the Prussian order, "Pour le Mérite," Knight Commander of the First Class Order of the Danebrog, and honorary member of foreign learned societies without number. He was created a baronet in 1883, and last year succeeded Lord Kelvin as President of the Royal Society. It would be more to the point if one could suitably describe the estimation in which he is held by the civilised world, and the enthusiasm he has always inspired amongst those who have come under his immediate personal influence.

AN EXPEDITION TO RUWENZORI.

A Naturalist in Mid-Africa; being an Account of a Journey to the Mountains of the Moon and Tanganyika. By G. F. E. Scott Elliot, M.A., F.L.S., F.R.G.S. 8vo. Pp. xvi + 413, with 50 illustrations and 4 maps. (London: A. D. Innes and Co., 1896.)

IN 1862 Baron von der Decken discovered on Kilima Njaro a number of plants which are quite different from those of the surrounding country, and are allied to those of the mountains of Abyssinia and the Cameroons, and of the lowlands of the Mediterranean and the Cape. The collections made by the late Joseph Thomson on the lower slopes of the same mountain and on the plateau of Masai-land proved the complex nature of the East African flora, and enabled Sir Joseph Hooker, in a paper which is one of the classics of African literature, to suggest the sources whence its constituents were derived. The interest thus aroused in the geographical affinities of this flora subsequently sent Sir H. H. Johnston and a host of German botanists to undertake detailed work in Kilima Njaro. Still more recently it inspired Mr. Scott Elliot to undertake his adventurous journey to Ruwenzori; for he tells us in his opening page, that the object of his expedition was "to solve the question of botanical areas which on this side of Africa had often puzzled me."

Mr. Scott Elliot left Mombasa in November 1893, and began his march into the interior along the track known as the "Uganda road." His men had been chosen for him by the agents of the British East Africa Company, and the selection does not appear to have been a good one. Mr. Scott Elliott had to dismiss his head man, the terms of whose engagement were at least remarkable; and his opinion of Zanzibari (or "Suahili," as he generally calls them) appears to have been permanently affected by the unsatisfactory character of his men. The narrative takes us rapidly across the country of the Wakamba to that of the Masai, in which the author had the misfortune to lose all his donkeys and their loads. He pressed on to Kavirondo, and thence along the northern shores of the Victoria Nyanza to Uganda. The direc route on to Ruwenzori was unsafe, as Kabbarega the king of Unyoro, was then at war with the British authorities. Anxious to avoid interference from this chief, whom he describes as one of the "ruffians of the sort who always obtain the sympathy of Mr. Labouchere," Mr. Scott Elliot kept southward along the western shore of the Nyanza. Having reached the Kagera River, he followed up this, and crossed Ankole to the southern end of Ruwenzori. This was the main goal of the expedition, and Mr. Scott Elliot spent four months exploring and collecting on the flanks of this snow-capped range. He made several attempts to reach the snow-line, but the nature of the work and illness prevented him. His account of mountaineering in Central Africa is not inviting.

"It was an awful ascent. Sometimes over deep moss, where jagged root-ends of heather seemed to spring out and stab ankles and knees at every step; sometimes through a dense wood of gnarled and twisted heather-trees, fifteen to twenty feet high, and covered with grey lichens, then down a steep little ravine and dense jungle; and things soon became very hopeless. Everything was shrouded in a cold chilling mist, and first one man and then another became knocked up, until at about 10 a.m. I was left alone. I went on by myself till 2 p.m. The effect of mountain sickness was most trying; I could not walk more than fifty yards without stopping to get breath, and by 2 p.m. I was utterly exhausted, and without food or anything to sleep in. This was at about 12,500 feet."

The level at which the author suffered from mountain sickness was unusually low; but it can be easily explained as due to the effects of malarial fever, which renders men liable to attacks of this malady, at elevations at which they would otherwise be safe.

Two of the men who took part in this excursion never recovered from it, and next time Mr. Scott Elliot tried the ascent, he went alone. He succeeded in reaching the height of 13,000 feet, after a weary struggle with rain, and cold and fever. Climbing over some half-buried boulders, he fell and nearly broke his leg; after this, numbed with cold, and shivering with fever, he crawled back to the point where he had left his blanket-bag, when fireless and foodless in the drenching rain, the night passed as "a sort of horrible dream."

Though Mr. Scott Elliot did not reach the summit of Ruwenzori, he reached the Alpine meadows below the snow-line, and this for his purpose was far more important.

From Ruwenzori he returned to the Kagera River at the point where he had left it, and followed it southward through Karagwe, of Speke's description of which Mr. Scott Elliot speaks most highly. He crossed Urundi to the northern end of Tanganyika; he journeyed down the lake by dhow, marched along the Stevenson road to Lake Nyasa, and then returned home by the Zambesi.

Mr. Scott Elliot's book consists of twenty chapters, which may be divided into two groups. The larger of these is devoted to the narrative of the expedition. This gives a most interesting record of a brilliant piece of pioneer exploration, which was carefully planned, was pluckily carried out in spite of exceptional discouragements, and is described with much charm of style and

many touches of dry humour. This part of the work is of high value, as the notes on the country, the sketches of the life of the people, and the account of the incidents of the march, enable one to form a clear and true idea of the present condition of British East Africa.

The second group of chapters (Nos. x., xi., xii., xviii. and xx.) are devoted to the discussion of general topics. These, taken in order of length, and beginning with the longest, deal with transport, meteorology and climate, outfit, botany and geology. The great length at which transport is treated, and the brevity of the chapter on botany, remind us of the main disappointment of the book. It is entitled "A Naturalist in Mid-Africa"; but, unfortunately, there is in it more about politics than about nature. The author is the only botanical expert who has travelled in British East Africa since Hildebrandt's journey to Ukamba, in 1877, and hence results of the highest importance might be expected from his labours. The chapter on botany is devoted to an attempt to explain the present distribution of the Africa floras. He assumes first, that in Miocene times a sea stretched "across the whole of the desert country which now extends from Beluchistan to the Atlantic, between Morocco and Senegal." But it is practically certain that no such sea has existed since at least Palæozoic times. The second assumption is a use of Körner's thermal constants, to which the author appeals to prohibit the movement of plants along certain directions, and to produce variation by a factor which is almost the same as Romanes' physiological selection. He tells us that in the Victoria Nyanza region, "the rainy season is from October to April. It follows from this that the plants there could not have come from the Congo area, for their climate is a very wet one, and their rainy season is from April to October."

If we are not always converted to Mr. Scott Elliot's theories, we always enjoy his sketches of wild life and of nature. He is seen at his best as an observer. The spirit of the true naturalist comes out in his sketches of life in the woods and on the hillside; and some of his observations, such as on the original limits of the Victoria Nyanza and on the shapes of the valleys of the upper streams of the Nile basin, are of great interest and value. He is always happier when speaking of plants and describing the habits of animals, than when dealing with men. Mr. Scott Elliot takes things sadly, and his quiet humour brings into relief the spirit of sadness that pervades the book. He draws a dismal picture of the conditions of life with a small expedition in Equatorial Africa; and then remarks that on his return people always asked him, "Did you enjoy yourself?" He appears to have been ill-used during his expedition by the officials of both the British East Africa Company and of the German territories. He repeatedly complains that naturalists at home are very inconsiderate of the difficulties of collectors. He grieves that his meteorological notes are of little service, for, as usual, "in the interval between my departure and return, quite new instruments and observations were found to be absolutely essential." In his dedication he describes his book as the "result of a most inconvenient love of botany." In his preface he regrets that he cannot use the map of Ruwenzori prepared from his materials by the Geographical Society, "as several inaccuracies were retained in deference to a more recognised authority than myself." He deplores that "insects are usually collected by travellers, but it is difficult to obtain any information about them in this country." Mr. Scott Elliot's complaint appears to be that the collections of English travellers are not described as thoroughly or as well as those of Germans, and that in consequence there is little inducement to Englishmen to undertake scientific exploration.

There are so few men willing to run the risks and spend their money in this work, that we greatly hope that Mr. Scott Elliot's complaints are not to be taken as proof of a widespread evil. British naturalists have exceptional opportunities for obtaining rich harvests of material from abroad; but owing to the neglect of systematic zoology and botany in our educational centres, the number of trained labourers who can work at them is far too few. The loss to science is no doubt very serious; but as it is impossible for a single collector to collect everything, a traveller can protect himself by devoting his attention to groups in which he knows that his materials will not be wasted.

ANALYTICAL CHEMISTRY.

Analytical Chemistry. By N. Menschutkin. Translated from the third German edition by James Locke. Pp. xii + 512. (London: Macmillan and Co., 1895.)

THERE is, perhaps, hardly any branch of chemistry so overstocked with text-books as that of analysis. In the work before us, however, the subject is presented in such a clear and original manner, that it can hardly fail to become as popular in this country as in Germany, where it has already reached a third edition.

In the preface the author states that although general and analytical chemistry are usually commenced together, yet, in his opinion, the study of the former should always precede that of the latter, the best order of attack being general, analytical, organic, and finally physical chemistry. In view of the difference of opinion in this country as to the best lines to follow in the elementary teaching of chemistry, the following remarks of Prof. Menschutkin are of sufficient interest to quote in full.

"The student cannot rightly turn to analytical chemistry until he has obtained a thorough preparation in the general science; and his knowledge of the latter is measured, not by the number of single and isolated facts with which he is familiar, but by the clearness with which he understands the fundamental chemical phenomena and theories. For these reasons I strongly advise the beginner not to devote himself too quickly to analytical chemistry, and my advice is justified by the character which its study must assume if it is to be of value."

Rather more than half of the book deals with qualitative analysis. The metals are grouped, as usual, according to the properties and modes of formation of their sulphides. Under the heading "General reactions," the corresponding compounds of all the methods of a group are given, and then, as "Special reactions," follow the properties of the chief compounds of each element used in analysis. Especial stress is laid upon the fact that every analytical reaction depends upon definite conditions, which must be known and fulfilled for the suc-

cessful performance of any given separation. The analysis of these conditions is one of the most admirable features of the book, complete explanations being given in all cases where the theory of the reactions is known (as in the separation of nickel and cobalt); conditions found to be necessary by experience, for which no theoretical reason can be given, are definitely stated to be empirical. One point emphasised here, to which no reference is made in our current text-books, has reference to the composition of the metallic sulphides obtained in the wet way. It is pointed out that the anhydrous sulphides as obtained in quantitative analysis differ considerably in their properties (colour, rate of oxidation) from the precipitates obtained in the ordinary course of qualitative work, and these differences of behaviour correspond to differences in composition. Thus the precipitates obtained with hydrogen and ammonium sulphides are in many cases hydrated sulphides (R(SH)(OH) rather than RS). The anhydrous sulphides are occasionally formed in solution, and might give rise to confusion in certain cases. Thus, whilst the ordinary hydrated sulphide of manganese is yellow or flesh-coloured, in presence of an excess of ammonia and ammonium sulphide a green precipitate of anhydrous manganous sulphide is sometimes formed, especially from hot solutions. Again, the black precipitate obtained by treating cupric solutions with hydrogen sulphide is Cu_4S_3, and not CuS, as usually stated, the latter substance, according to Prof. Menschutkin, being unknown.

The analytical properties of the rarer metals are briefly treated in separate chapters. It would have added much to the scientific value of the book if this artificial distinction between ordinary and so-called "rare" metals could have been dispensed with. The present stereotyped mode of treatment is the chief cause of the want of knowledge by the average student of the properties and reactions of metals such as gold, platinum, cerium, uranium, and others that can only be conventionally considered as "rare."

The second half of the book deals with quantitative analysis. The descriptions are concise and the methods well chosen, but are hardly sufficiently detailed for the beginner.

OUR BOOK SHELF.

Grundriss der Krystallographie für Studirende und zum Selbstunterricht. By Gottlob Linck. Pp. vi + 252, 482 figures, and 2 plates. (Jena: Gustav Fischer, 1896.)

This book makes no pretence at supplanting such well-known works as those of Groth and Liebisch, but is intended for the less advanced student, and more especially for the chemist, to whom the necessity of some knowledge of crystallography is becoming increasingly felt. Except in one important particular, little attempt is made to break away from old methods of treatment. The thirty-two classes of symmetry are not treated as independent, but crystal symmetry is distributed in the usual way into the six systems, and under each system are described the holohedral, hemihedral and tetartohedral forms. Both the Naumann and the Millerian symbols for the faces are used, but greater prominence is given to the former.

An important innovation, however, is made in the chapter on the optical characters of crystals. Here, we are glad to see, the author has followed the example of Prof. Groth and adopted the purely geometrical treatment involving the use of the "Optical Indicatrix," as devised by Mr. Fletcher.

The book is fairly evenly divided between the two sections dealing respectively with the geometrical and the physical characters of crystals, about a hundred pages being devoted to each. As it is not written for the advanced student, the subject of the calculation and graphic representation of crystals is not touched upon.

The book appears to be well adapted to the purpose for which it is intended. G. T. P.

Cyanide Processes. By E. B. Wilson, E.M. Pp. 116 (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1896.)

It is difficult to say with what object this little book has been written, and so it would perhaps be rash to assert that its object has not been attained. It is, at any rate, to be regretted that Mr. Wilson's work ever saw the light, as it is distinctly inferior to each of the half-dozen accounts which have already appeared of the cyanide process for the extraction of gold from its ores, and can only mislead and confuse those who expect to learn something from it. It is evident, from his own statements in the preface and elsewhere, that the author has derived much of his acquaintance with the subject from Patent Office literature, although he also claims to have read extracts from technical journals and other periodicals. He has not touched on mechanical details, but has confined himself to expounding the chemical principles of the process, which he appears to understand very imperfectly. The book is full of mistakes, such, for example, as that "the standard solution of cyanide contains from 0·5 to 1·5 per cent.," and that mercury oxidises quickly in the air at ordinary temperatures. On p. 74 it is stated that "the gold positive dissolves to the cyanide solution negative, with the result that the gold cyanide solution is positive. . . . Whether this electrolyte becomes converted into an electrode by absorbing the gold we are unable to say, but when they become 'cations' the gold is in the metallic state and the potassium cyanide is immediately set free." The book is well supplied with such statements as this. T. K. Rose.

The Treatment of Phthisis. By Dr. Arthur Ransome, M.A., F.R.S. Pp. viii + 237. (London: Smith, Elder, and Co., 1896.)

Medical men will be grateful for this treatise on the treatment of phthisical patients. The first part of the work comprises a general statement on the etiology pathology of phthisis, and the limits of infection; while the second part deals with the special and medicinal treatment of the malady. The contents are largely confined to descriptions of methods of treatment which have been personally used by the author, and results which have come under his own experience; but they, nevertheless, constitute a broad account of the nature and means of combating phthisis, and one which will give physicians brighter views as to the possibility of cure in the disease.

A Text-book of Applied Mechanics. Vol. I. By Alexander Jamieson, M.I.C.E., Professor of Electric Engineering in the Glasgow and West of Scotland Technical College, &c. Pp. 416. (London: Charles Griffin and Co., 1895.)

The influence of Rankine is apparent here; the ground covered is much the same as in Rankine's "Applied Mechanics," but the treatment is more elementary, and the illustrative exercises and diagrams of a modern character.

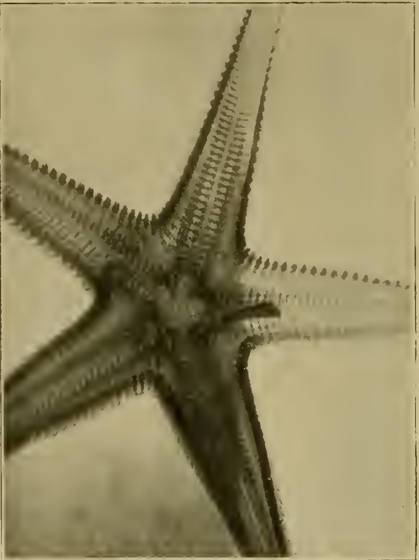
If our writers of elementary school books on Mechanics, all copied from each other and almost exactly alike, could be persuaded to lift their eyes from their own pages and look elsewhere for novelty and reality, they would derive some profit from a treatise such as this. G.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Biological Application of Röntgen Photography.

THE accompanying Röntgen radiograph of *Astrospecten irregularis* was made in the physical department of this college, for a popular lecture on the new photography given by Prof. H. Stroud. It will be seen that not only are the ossicles of the oral surface fairly successfully shown through the thickness of the body and arms, markedly the first of the series of adambulacra, but certain striking and unlooked-for objects appear as well. On dissection the dark conical body to the right proves to be a large piece of the shell of Dentalium lying in one of the cæca of that arm. The oval bodies, one in each of the cæca of the opposite arm, are masses of sand and indigestible material enclosed in the thinned shells of molluscan victims. These are made by the action of the cilia, and form a convenient way of getting rid of the useless matter by way of mouth. The minute anus, indeed,



Astropecten irregularis.

is quite inadequate, and is doubtless used more for fluid than solid evacuation. The madreporite plate and stone canal are seen in the inter-radius below and between the bodies referred to; and the position of the stone canal was in fact the guide in determining their position. The darkish mass in the cæcum to the left of the stone canal consists mainly of broken and whole shells of young Cardia. The stomach was filled with a whole common mussel (*Mytilus edulis*), minus the shell, and this is quite transparent. The paxillæ will be seen to occur as dots all over the body and arms. A block of wood, which was laid over part of the star-fish, has evidently only made a part of the picture lighter.

A radiograph of *Solaster papposus*, with the young Cribella, is enclosed for comparison. Though interesting also in regard to the skeletal parts shown, there is nothing calling for further note here, and they were not dissected.

All three were spirit specimens, and were got at St. Andrews some years ago. ALEXANDER MEEK.

Durham College of Science, Newcastle-on-Tyne, April 25.

Barisal Guns.

IN the correspondence on this subject I have not noticed any reference to the noises said to be heard in the mountains of the peninsula of Sinai. In his "Sinai and Palestine" (ed. 1868, pp. 13–14), the late Dean Stanley refers to "the mysterious noises which have from time to time been heard on the summit of Jebel Musa, in the neighbourhood of Um Shaumer, and in the mountain of Nakus or the Bell, so called from the legend that the sounds proceed from the bells of a convent enclosed within the mountain. In this last instance the sound is supposed to originate in the rush of sound down the mountain side. . . . In the case of Jebel Musa, where it is said that the monks had originally settled on the highest peak, but were by these strange noises driven down to their present seat in the valley, and in the case of Um Shaumer, where it was described to Burckhardt as like the sound of artillery, the precise cause has never been ascertained."

Burckhardt ("Travels in Syria and the Holy Land," 1822, p. 591) refers to these noises and says: "The wind and weather are not believed to have any effect upon the sound."

Failand, April 30. EDW. FRY.

The New Education Bill and Libraries, Museums, and Art Galleries.

REFERRING to the letter by "C." in NATURE for April 23, p. 580, I would urge the importance of his suggestion, but would go further and suggest that all institutions in England and Wales supported out of a rate raised under the Public Libraries Acts or the Museums and Gymnasiums Act, should be put under the management and control of the same local authority as may be appointed for elementary, technical and secondary education.

The management of educational institutions cannot be unified so long as such essentially educational work as that done in public libraries, museums, and art galleries does not come under the purview of the local education authority. There should, of course, be conditions inserted in any Bill having the object suggested to secure the expenditure of the rates received under the special Acts referred to, on the support of libraries, museums, art galleries and gymnasiums.

At present the Public Libraries Acts may be adopted and a rate levied, not one penny of which goes to the support of a library or museum. A certain Lancashire local authority applies the rate for purposes which would have been equally covered by the adoption of the Technical Instruction Acts. On the other hand, some public libraries and museums obtain subsidies out of the funds received by corporations under the Local Taxation (Customs and Excise) Act, though usually on condition that strictly educational books or objects are purchased out of the grants given.

I hope this subject will receive due consideration from such parliamentary advocates of scientific education as Sir John Lubbock and the members who act with him.

In conclusion, may I refer all who are interested in this subject to a paper entitled "The Relationship of the Public Library Committee to other Educational Bodies," published in the *Library* (vol. vii. p. 129), the organ of the Library Association of the United Kingdom. JOHN J. OGLE.

Free Public Library, Museum, and Technical School, Bootle, April 28.

Magical Growth of Plants.

I NOTICE in NATURE of April 9 that mention is made of the experiments of M. Ragonneau in connection with what is termed the magical growth of plants. At the time when M. Ragonneau's statements were first brought under my notice, I endeavoured as nearly as might be to repeat his experiments. I first used formic acid diluted 1 : 5000, the strength stated by M. Ragonneau as being that most successfully used by him. The soil was thoroughly dried, and was some which I had carefully prepared for growing Begonia seed. The seeds used were those of the Scotch thistle (*Onopordium Acanthium*), a soft and easily-grown seed. The experiments were carried out in an ordinary greenhouse with temperature ranging from 55° F. to 75° F.; and although I took every precaution to avoid mischance, the seeds have not to

this day shown any signs of life whatever, although seeds from the same packet, planted simultaneously under ordinary circumstances, are now well-grown young plants. After my first failure, I procured pure concentrated formic acid (sp. gr. 1·300) freshly made, and on repeating the experiments with it, other things being the same as in the former experiment, the result was again entirely negative. I then tried various other seeds, first soaking them in water for periods varying from five hours to three days before treating them with the acid, but all with no result. So far as I could judge, the only effect of the acid was to increase the density of the seed and to retard the growth, so much so that some of the seeds (common Lupinus), which under formic acid showed no signs of growth, as soon as they were thoroughly washed and placed under normal conditions began to germinate in the usual way. Since these experiments I have tried many different seeds and many different strengths, but have only so far succeeded in retarding their growth. I also attempted to inject the acid (1·5000) by means of a hypodermic syringe into the substance of growing seeds and bulbs, and in two instances I succeeded in killing a Begonia tuber and an Arum lily, and certainly none of the other plants treated showed the faintest symptom of increased vitality. W. R. M. SEMPLE.

Hendford Park, Yeovil, April 11.

Rooks at Nesting Time.

OPPOSITE my windows are lofty elms on which rooks have established themselves. In one tree there are three nests with sitting birds; a fourth nest, which was built this spring, has never been fully occupied, and a fifth is now in course of construction.

It is in relation to the last two nests that a singular fact is noticeable. A pair of rooks are apparently mated, flying off and returning together, and roosting at night on the same branch.

Both are engaged in building, but on different boughs; both select the same tree, almost the same branch, for twigs, and both return home spray in beak. But while the hen bird flies to the incomplete nest (which she has built up, unaided, from the beginning, and is now three-fourths finished), the cock bird settles on the old nest, at the other side of the tree, and adds an upper story to an already capacious mansion.

How is this binary housekeeping or nest-building to be explained?

There have been further complications in the rookery since I wrote the foregoing a fortnight ago.

Then the situation was that a couple of rooks (apparently paired) were working together in collecting twigs; but while the hen bird carried hers to a new nest on the north side of an elm, the cock took his to an old nest on the south side.

Still they roosted and flew together, and behaved as engaged rooks should do, the cock now and then bringing a twig or two to the hen's nest, but chiefly working on his own.

In a few days the cock brought home another mate, and both birds set to work at the old nest. Although, for a day or two, appearances were still preserved, the original hen at last resented this trifling with her affections; she pecked at and drove off the cock, stole lining from his nest, and has since lived a life solitary and misanthropic. I see no sign of a new mate, but the hen sits by or on her own nest, and routs all new-comers who approach it.

On the same tree I have seen a singular case of wholesale burglary in which the sufferers are the new occupants of the old nest I have referred to, and the burglars a new pair of rooks. For a week they strove and failed to build a nest in an honest way, *i.e.* by breaking twigs from other trees; but they made no progress, the wind repeatedly blowing away the foundation during their absence in quest of materials.

One night, however, the wind dropped. The pair got up very early next morning, fell on the old nest (the tenants having gone off to feed), and by nine o'clock had three parts finished a new nest, on the north-west side, built entirely out of plunder from the old nest. To this they have since added a clumsy top story made of new materials.

One other curious fact, and I will take up no more of your space. On another elm a stray hen had persisted in thrusting her unwelcome attentions on an established pair now feeding their squabs. She had been there some days, and apparently was at last tolerated. One night, however, as many as ten desperate battles took place; the combatants falling, still locked in combat, from the topmost bough almost to the ground, and as often returning to the fray at the nest-side. This morning Aunt Caroline is *non est*, but I expect she will turn up again before long. Meanwhile, due perhaps to the extra food the young birds got by the exertions of the aunt, they are the largest and strongest in the rookery. F. E. BAINES.

Leamington, April 28.

An Auroral Display on May 2.

ON the evening of Saturday, May 2, at Filey (Yorkshire) I observed faint indications of an auroral display as early as 10 o'clock. On going out of the house at 11.10, five streaks of light were seen in the north, and a small cloud of light appeared on the horizon, which quickly rose and formed a perfect bow of light of great length and some 10° above the horizon at its highest point; by 11.15 all the streaks had disappeared. At 11.30, rapid beams of light were seen following the curve of the bow from west to east, each succeeded by straight arrow-like flashes above the bow in the opposite direction; 11.36, streaks again appeared on the eastern side; 11.39, the bow threw off clouds of light radially, first on the western, then on the eastern side; 11.42, the phenomena observed at 11.30 again set in on the western side; 11.49, the bow became very sharp towards the west and threw out streaks of light, while towards the east it became broken and flickering; 11.55, streamers appeared on the eastern side, and the bow became contracted on this side and smaller, striking the horizon at a higher angle; 11.58, the bow thickened and threw off radial clouds again; 12.1, a fine streamer appeared on the extreme eastern side; 12.3, the bow became very irregular, and for the first time the streamers appeared to start below the bow, three very sharp ones forming towards the east; 12.7, a second bow formed below the original one; 12.9, the bow broke up entirely towards the east into fine streamers, radial clouds of light being thrown off in the west; 12.20, bow became very indistinct in the west, and streamers gave place to clouds of light in the east; 12.22, streamers reappeared in the east; 12.25, arc of the bow reformed; 12.27, bow narrowed down and broke into two bows; 12.30, bow became irregular and sank down towards the horizon; 12.37, bow disappeared and faint streamers formed. After this a gradual fading set in, but the light was still visible though feeble at 1 a.m. The atmosphere had been exceptionally clear all through the day. A. E. M.

Felsted School, Essex.

Daylight Meteor, April 12.

THE meteor referred to in NATURE of April 23 (p. 581), was seen by me in Glasgow, low down on the S.E. horizon, at 8.5 p.m. The position of its visible path was carefully noted at the time in relation to a church spire, which it just seemed to touch. On April 27, at 10.30 p.m. the céntre of the full moon was 2° above this point, its declination was therefore 22° 13′ S., and its R.A. on April 12 at 8.5 p.m. was 10h 39m. On account of some intervening shrubs the meteor's path was only visible over a distance of 10°, but the declination seemed to remain unchanged. C. E. STROMEYER.

Glasgow, May 2.

THE ROYAL SOCIETY SELECTED CANDIDATES.

THE following are the names and qualifications of the fifteen candidates recommended by the Council of the Royal Society for election this year:—

SIR GEORGE SYDENHAM CLARKE,

Major, R.E., K.C.M.G., Secretary to the Colonial Defence Committee and Associate Member of the Ordnance Committee. Late Secretary to the Royal Commission on Administration of the Naval and Military Services. Examiner to the Science and Art Department and the Military Education Department. Formerly (from 1871 to 1880) Instructor in Geometrical Drawing in the Royal Engineering College, Cooper's Hill. Joint Author of paper "On some Figures Exhibiting the Motion of Vibrating Bodies, and on a New Method for Determining the Speed of Machines" (*Proc. Roy. Soc.*, vol. xxvi., pp. 157–163), and of a paper "On the Determination of the Rate of Vibration of Tuning Forks" (*Phil. Trans.*, 1880, pp. 1–14). Author of

"Practical Geometry and Engineering Drawing" (1875): "Principles of Graphic Statics" (1879): "Perspective Explained and Illustrated" (1884): "Plevna: a Study of the Operations of 1877" (1880); "Official Report on the Effects of the Bombardment of Alexandria" (1882); "Fortification: Past, Present, and Future" (1890); and of a large number of papers on naval and military subjects.

J. Norman Collie,

Ph.D., Assistant Professor of Chemistry, University College, London. Distinguished as a worker in Organic Chemistry. Author of numerous papers published during the period from 1881 to the present time in the *Proceedings* and *Transactions* of the Royal Society of Edinburgh, *Liebig's Annalen*, the *Berichte* of the German Chemical Society, and the *Transactions* of the Chemical Society. His earlier papers relate chiefly to the study of phosphonium and phosphine derivatives and allied ammonium compounds, their behaviour when decomposed by heat having been thoroughly studied by him. Of late years he has made important contributions to our knowledge of dehydracetic acid, having described a number of very remarkable "condensations," whereby it is converted into pyridine, orcinol and naphthalene derivatives.

Arthur Matthew Weld Downing,

M.A., D.Sc., Vice-President of the Royal Astronomical Society. President of the British Astronomical Association. Superintendent of the *Nautical Almanac*. Author of the following papers, among many others, which have appeared in the *Monthly Notices* of the Royal Astronomical Society:—"Proper Motions of Certain Stars in the Greenwich Seven Year Catalogue for 1864" (vol. xxxviii., p. 514); "On the N.P.D.'s of the Greenwich Seven Year Catalogue for 1860" (vol. xl., p. 85); "The Greenwich Standard Right Ascensions" (vol. xl., p. 162): "The Possible Ten-month Period of Variation in Latitude" (vol. xl., p. 430); "On the N.P.D.'s of the Cape Catalogue for 1880, and on the Greenwich and Cape Mean Systems of North Polar Distances" (vol. xlii., p. 20); "Discussion of the Observations of γ Draconis, made with the Greenwich Reflex Zenith Tube, during the years 1857-75" (vol. xlii., p. 326); "On the relative Motion of the Components of p Eridani" (vol. xliii., p. 263); "On the Orbit of γ Coronæ Australis" (vol. xliii., p. 368); "On the Periodic Time of α Centauri" (vol. xlv., p. 151); "A Comparison of the Star Places of the Argentine General Catalogue for 1875 with those of the Cape Catalogue, 1880" (vol. xlvii., p. 446); "Positions for 1750 and Proper Motions of 154 Stars, S. of −29° dec., from a revision of Powalky's Reduction of the Star Places of Lacaille's Astronomiæ Fundamenta" (vol. xlviii., p. 322); "Discussion of Washington Observations of the Sun, 1875-83" (vol. xlix., p. 431); "Corrections to the Orbit of Juno" (vol. l., p. 487); "The Orbit of Flora, with corrections to Brünnow's Tafeln der Flora" (vol. lii., p. 585).

Francis Elgar,

LL.D., F.R.S.E., Naval Architect and Engineer, Professor of Naval Architecture and Marine Engineering in the University of Glasgow, and Director of Her Majesty's Dockyards. Prof. Elgar has advanced the science of naval architecture by original investigations, notably in the departments of stability and of the structural strength of ships. These are described in papers communicated to the Royal Society, one of which is printed *in extenso* in *Roy. Soc. Proc.* No. 232, 1884. An abstract of the other was read before the Society on January 14, 1886. The first describes an important and novel principle which determines the variation of stability with draught of water, and the second greatly advances the investigation of the straining actions upon ships at sea. Prof. Elgar is distinguished for his acquaintance with the theory and practice of Naval Architecture, and was unanimously elected on that account by the Court of Glasgow University to the "John Elder" Chair of Naval Architectural and Marine Engineering. He is eminently distinguished as a Naval Architect and Engineer, being a Fellow of the late Royal Society of Naval Architecture and Marine Engineering, and Member of Council of the Institution of Naval Architects, Member of Council of the Institute of Engineers and Shipbuilders in Scotland, and Member of the Institution of Civil Engineers. He was appointed in January 1884 by the Council of the Institution of Naval Architects to sit as their representative upon the Committee formed by the President of the Board of Trade to frame rules for regulating the load lines of ships.

Supplementary Certificate.—Is now a representative of the Institution of Naval Architects upon the Technical Committee of Lloyd's Register of British and Foreign Shipping. Was Vice-President of the International Jury in the class of *Matériel de Navigation et Sauvetage*, in the Paris Exhibition, 1889. Is the Consulting Naval Architect for the Cunard Steamers *Campania* and *Lucania*, which are the most powerful and, with the exception of the *Great Eastern*, the largest ships ever built.

Andrew Gray,

M.A. (Glasgow), F.R.S.E., Professor of Physics, University College of North Wales. Examiner in Mathematics for degrees in the University of Glasgow. For five years Private Assistant and Secretary to Sir W. Thomson (Lord Kelvin); for four years Official Assistant to the Professor of Natural Philosophy in the University of Glasgow; and for the last nine years in his present post. Distinguished for his acquaintance with theoretical and experimental physics. Author of the following scientific works and papers:—"Absolute Measurements in Electricity and Magnetism" (1889); "Theory and Practice of Absolute Measurements in Electricity and Magnetism" (vol. i., 1888; vol. ii., in two parts, 1893); "A Treatise on Magnetism and Electricity," shortly to be published; "On the Determination in Absolute Units of the Intensity of Powerful Magnetic Fields" (*Phil. Mag.*, 1883); "On the Dynamical Theory of Electro-magnetic Action" (*ibid.*, 1890); "On the Calculation of the Induction Coefficients of Coils" (*ibid.*, 1892); "On a New Reflecting Galvanometer of great sensibility, and on New Forms of Astatic Galvanometers," jointly with T. Gray (*Proc. Roy. Soc.*, 1884); "On the Relation between the Electrical Qualities and the Chemical Composition of Glass and Allied Substances," Part I., jointly with T. Gray and J. J. Dobbie (*Proc. Roy. Soc.*, 1884) "On the Electro-magnetic Theory of the Rotation of the Plane of Polarised Light" (*Rept. Brit. Assoc*, 1891).

George Jennings Hinde,

Ph.D. (Munich), F.G.S. Studied at University College, Toronto, Canada (1874-75); afterwards (1879-80) studied, under Dr. Karl Zittel, in the University of Munich, where he graduated. Author of numerous papers on Geology and Palæontology, viz.:—"The Glacial and Interglacial Strata of Scarboro' Heights and other localities near Toronto, Ontario" (*Canad. Journ.*, 1877, pp. 28, one plate); "On Conodonts from the Cambro-Silurian and Devonian of Canada and the United States" (*Quart. Journ. Geol. Soc.*, vol. xxxv., pp. 351-369, pl. xv.-xviii., 1879); "On Annelid Jaws from the Cambro-Silurian and Devonian of Canada and the Lower Carboniferous of Scotland (*op. cit.*, vol. xxxv., pp. 370-389, pl. xviii.-xx., 1879); "On a New Genus of Favosite Coral from the Upper Silurian, Manitoulin Island, Lake Huron" (*Geol. Mag.*, 1879, pp. 244-246); "Fossil Sponge Spicules from the Upper Chalk, Horstead, Norfolk" (*Inaug. Dissert.*, Munich, 1880, 8vo, pp. 84, 5 plates); "On Annelid Jaws from Wenlock and Ludlow formations of the West of England" (*Quart. Journ. Geol. Soc.*, vol. xxxvi., pp. 368-378, pl. xiv., 1880); "Notes on Fossil *Calcispongiæ* with Descriptions of New Species" (*Ann. and Mag. Nat. Hist.*, ser. 5, vol. x., pp. 185-205, pl. x.-xii., 1882); "On Annelid Remains from the Silurian Strata of the Island of Gotland" (*Bihang till K. Svenska Vet. Akad. Handl.*, Bd. vii. No. 5, pp. 28, 3 plates, 8vo, Stockh., 1882); "Catalogue of the Fossil Sponges in the British Museum (Nat. Hist.) with Descriptions of New and little-known Species" (4to. pp. 248, 38 plates, 1883); "On some Fossil *Calcispongiæ* from the Well-boring at Richmond, Surrey" (*Quart. Journ. Geol. Soc.*, vol. xl., pp. 778-783, 1 plate, 1884); "On the Structure and Affinities of the *Receptaculitidæ*," &c. (*op. cit.*, vol. xl., pp 795-849, pl. xxxvi.-xxxvii., 1884); "On a New Species of Crinoid with Articulating Spines" (*Ann and Mag. Nat. Hist.*, ser. 5, vol. xv., pp. 157-173, pl. vi., 1885); "On Beds of Sponge Remains in the Lower and Upper Greensands of the South of England" (*Phil. Trans.*, 1885, vol. clxxvi., p. 51, pl. xl.-xlv.)

Supplementary Certificate.—"A Monograph of the British Fossil Sponges" (Palæontographical Soc., Part I., 1887, pp. 1-92, pl. i.-viii.; Part II., 1888, pp. 93-188, pl. ix.; Part III., 1893, pp. 189-254, pl. x.-xix.); "On the Cherts and Siliceous Schists of the Permo-Carboniferous of Spitzbergen" (*Geol. Mag.*, 1888, pp. 241-251, 1 pl.); "On some New species of *Uruguaya* (Carter), with Remarks on the Genus" (*Ann. and Mag. Nat. Hist.*, ser. 6, vol. ii., 1888, pp. 1-12, 1 pl.); "On a True

Deuconid Calcisponge from the Middle Lias of Northamptonshire" (*ibid.*, vol. iv., 1889, pp. 325–358, 1 pl.); "On Archæocyathus, Billings, and on other Genera allied to it, from Cambrian Strata, &c." (*Quart. Journ. Geol. Soc.*, vol. xlv., 1889, pp. 125–148, 1 pl.); "Notes on Radiolaria from the Lower Palæozoic Rocks of the South of Scotland" (*Ann. and Mag. Nat. Hist.*, ser. 6, vol. vi., 1890, pp. 40–59, 2 pl.); "On the Sponge Remains in the Tertiary Strata, near Oamaru, New Zealand" (in conjunction with Mr. W. M. Holmes), (*Linn. Soc. Journ. Zool.*, vol. xxiv., 1891, pp. 177–262, with 9 pl.); "Note on a Radiolarian Rock from Fanny Bay, Port Darwin, Australia" (*Quart. Journ. Geol. Soc.*, vol. xlix., 1893, pp. 221–226, 1 pl.). Has paid special attention to the microscopic structure of Siliceous Deposits and Cherts, and has demonstrated the existence of Sponges, Radiolaria, and other organisms in them, and as largely composing such deposits, of all ages, and from the most distant parts of the world.

Henry Alexander Miers,

M.A. (Oxon), F.G.S., F.C.S., Assistant in the Department of Minerals, British Museum (Nat. Hist.). Has improved the Adams instrument for the measurement of optic axal angles; devised a form of goniometer for measuring the angles of growing crystals; and a stage-goniometer for use with the microscope. Distinguished as a mineralogist and crystallographer, and author of important investigations in crystallography and mineralogy, 1882–94, as under:—"Cerussit von La Croix" *Zeitsch. für Krystall.*, vi.); "The Crystalline Form of Meneghinite" (*Mineral. Mag.*, v.); "Hemihedrism of Cuprite" *Phil. Mag.*, xviii.); "Monagite from Cornwall and Connellite" (*Mineral. Mag.*, vi.); "Crystallography of Bromostrychnine" (*Journ. Chem. Soc.*, xlvii.); "Crystallography of Tricupric Sulphate" (*ibid.*); "Orthoclase from Kilima-n-jaro and Adrelavia, Switzerland" (*Mineral. Mag.*, vii.); "New Cornish Mineral" (*Mineral. Mag.*, vii.); "Zonenformal für Orthogonate Systeme" *Zeitsch. für Krystall.*, xii.); "Crystals for Baric Slag" (*Journ. Chem. Soc.*, li.); "Use of Gnomonic Projection" (*Mineral. Mag.*, vii.); "Calcites, Egremont, Cumberland" (*ibid.*, viii.); "Pyrargyrite and Proustite" (*ibid.*, viii.); "Mineralogical Notes—Polybasite, Aikinite, Quartz, Cuprite, and Locality of Turnerite" (*ibid.*); "Stephanite and Kaolinite" (*ibid.*, ix.); "Sanguinite (new mineral), Krennerite" (*ibid.*); "Ullmannite Tetartohedrism" (*ibid.*); "Student's Goniometer" (*ibid.*); "Orpiment" (*ibid.*, x.); "Cornwall Danalite" (with G. T. Prior, *ibid.*); (with W. J. Pope) "Mittheil. aus dem Krystall Laboratorium des City and Guilds of London Inst." (*Zeitsch. für Krystall.*, xx.); "Spangolite from Cornwall (*Neues Jahresbr. für Min.*, ii.); "Quartz from North Carolina" (*Amer. Journ. Sci.*, xlvi.); "Xanthocanite," &c. (*Mineral. Mag.*, x.); "Spangolite" (*ibid.*, x.); "On a New Method of Measuring Crystals," &c. (*Rept. Brit. Assoc.*, Nature, l.).

Frederick Walker Mott,

M.D. (Lond.), F.R.C.P. Lecturer on Physiology, Charing Cross Hospital. Distinguished as a physiologist. The following are his most important published papers:—"Bacteria, or their Antecedents, in Healthy Tissues" (with Prof. Horsley—*Journ. of Physiol.*, 1883); "Myxofibroma of Spinal Cord" (*Brain*, 1888); "Cardio-vascular Nutrition and its relation to Sudden Death" (*Practitioner*, 1888); "Pathology of Pernicious Anæmia" (*ibid.*, 1890); "Clarke's Column in Man, Monkey, and Dog" (*Journ. of Anat. and Physiol.*, 1887); "On Eye Movements produced by Cortical Faradisation of the Monkey's Brain" (with Prof. Schäfer—*Brain*, 1890, and Internat. Med. Congress, Berlin); "On Movements resulting from Excitation of the Corpus Callosum in Monkeys" (with Prof. Schäfer—*Brain*, 1891); "Complete Sclerosis of Golt's Column" (*Internat. Journ. of Med. Sci.*, 1891); "The Results of Hemisection of the Spinal Cord in Monkeys" (*Phil. Trans.*, 1892).

Supplementary Certificate.—Physiologist and Neurologist. Secretary of the Neurological Society. Pathologist to the London County Council Asylums. Has published the following papers recently:—"The Bipolar Cells of the Spinal Cord and their Connections" (*Brain*, 1891); "Ascending Degenerations of the Spinal Cord" (*ibid.*, 1892); Article on "Pernicious Anæmia" ("Quain's Dict. of Med.," 2nd edit.); "A Case of Multiple Infective Neuritis" (*Clin. Soc. Trans.*); "A Case of Amystrophic Lateral Sclerosis with Degeneration of the Motor Path from the Cortex to the Periphery" (*Brain*, 1895); "Experimental Enquiry upon the Afferent Tracts of the Central Nervous System" (*ibid.*, 1895); "The Sensori-Motor Functions of the Central Convolutions of the Cerebral Cortex" (*Journ. Physiol.*, 1894); "Experiments upon the Influence of Sensory Nerve upon Movement and Nutrition of the Limbs" (Preliminary Communication, with Prof. Sherrington, F.R.S.) (*Proc. Roy. Soc.*, vol. lvii.).

John Murray,

Ph.D. (Jena)., LL.D. (Edin.), D.Sc. (Camb.). One of the Naturalists on board the *Challenger*, 1872–76. First Assistant on the *Challenger* Editorial Staff, 1876–82. Editor and Director of the *Challenger* publications, 1882–95. Editor of the Reports on the Scientific Results of H.M.S. *Challenger*; joint Author of the Narrative of the Cruise of the *Challenger*, and of the Report on Deep-Sea Deposits; Author of a Summary of the Scientific Results of the *Challenger* Expedition; Author of numerous Papers dealing with Oceanography, Physical Geography, and Marine Biology.

Karl Pearson,

M.A., LL.B., late Fellow of King's College, Cambridge. Professor of Mathematics and Mechanics at University College, London. Editor and joint Author of vol. i. of Todhunter's "History of Elasticity." Author of the following papers on Elasticity:—"On the Distortion of a Solid Elastic Sphere" (*Quart. Journ. Math.*, vol. xvi.); "On Twists in an Infinite Elastic Medium" (*Mess. of Math.*, vol. xiii.); "On the Flexure of Heavy Beams" (*Quart. Journ Math.*, vol. xxiv.); "On the Generalised Equations of Elasticity, and their Application to the Wave Theory of Light" (*Proc. Lond. Math. Soc.*, vol. xx.); "On Energy in an Elastic Solid" (*Mess. of Math.*, 1889); "On Wöhler's Experiments on Alternating Stress" (*ibid.*, 1890): also "Contributions to the Mathematical Theory of Evolution" (*Phil. Trans.*, 1894).

Thomas Roscoe Rede Stebbing,

M.A. (Oxon.), B.A. (Lond.). Clerk in Holy Orders. Late Fellow and Tutor of Worcester College. Author of Report on the Amphipoda collected by H.M.S. *Challenger*, a task which has occupied him almost exclusively for six years. It forms three large volumes (vol. xxix. of the Report), and consists of 1774 pages, and 212 plates, with a map, 4to, 1888. (The figures were all drawn by the author.) Also author of the following:—"Note on *Calceola sandalina*, Lmk." (*Geol. Mag.*, vol. x., pp. 57–61, pl. v., 1873); "A New Species of Sessile-eyed Crustaceans" (*Ann. and Mag. Nat. Hist.*, ser. 4, vol. xvii., pp. 73–80, pl. iv.–v., 1876); "Amphipodous Crustaceans (*Hyale, Aronyx, &c.*)" (*ibid.*, pp. 337–346, pl. xviii.–xix., 1876); "Some New and little-known Amphipodous Crustaceans" (*ibid.*, vol. xviii., pp. 443–449, pls. xix.–xx., 1876); "On Sessile-eyed Crustaceans" (*ibid.*, ser. 5, vol. 1., pp. 31–37, pl. v., 1878); "On Species of Amphipodous Crustaceans" (*ibid.*, vol. 11., pp. 464–370, pl. xv., 1878); "The Sessile-eyed Crustaceans of Devonshire" (*Trans. Devon. Assoc.*, vol. xi., pp. 516–524, 1879); "On *Gastrosaccus spinifer*" (*Ann. and Mag. Nat. Hist.*, ser. 5, vol. vi., pp. 114–118, pl. iii., and p. 328, 1880); "A New English Amphipodous Crustacean" (*ibid.*, vol. xv., pp. 58–62, pl. ii., 1885); "On the Crustacea Isopoda of the *Lightning*, *Porcupine*, and *Valorous* Expeditions" (joint paper with the Rev. A. M. Norman, *Trans. Zool. Soc.*, 1886, vol. xii., pp. 77–142, pls. xvi.–xxvii.); "Exotic Amphipoda from Singapore and New Zealand" (*ibid.*, vol. xii., pp. 199–220, pls. xxxviii.–ix.); Address as President of Devonshire Assoc. (*Trans. Devon. Assoc.*, 1884).

Supplementary Certificate.—Author of "The Naturalist of Cumbræ; being the Life of David Robertson, F.L.S., F.G.S., by his Friend" (1891)" "The right Generic Names of some Amphipoda" (*Ann. and Mag. Nat. Hist.*, 1890); "Sessile-eyed Crustaceans" (*ibid.*, pl. xv.–xvi., 1891); "On the genus *Urothœ* and a new genus *Urothoides*" (*Trans. Zool. Soc.*, pl. i.–iv., 1891); "A History of Crustacea" and "Recent Malacostraceæ" (1893); "A New Pedunculated Cirripede" (*Ann. and Mag. Nat. Hist.*, pl. xv., 1894); "The Amphipoda collected during the Voyages of the *Willem Barents* in the Arctic Seas in the Years 1880–84" (*Soc. Nat. Art. Mag.*, Amsterdam, 1894, pl. i.–vii.); "On the Amphipoda of the *Buccaneer*" (*Zool. Soc. Trans.*, 1895, pls. i.–iv.); "Notes on Crustacea"

(*Ann. and Mag. Nat. Hist.*, pl. ii., 1895); "On Four New British Amphipoda (Stebbing and Robertson, *Zool. Soc. Trans.*, vol. xiii., pl. v.-vi., 1891).

CHARLES STEWART,

M.R.C.S., President of the Linnean Society. Conservator of the Museum of the Royal College of Surgeons, and Hunterian Professor of Human and Comparative Anatomy. Late lecturer on Comparative Anatomy, and joint lecturer on Physiology at St. Thomas's Hospital. Distinguished as a Biologist. Author of the following papers :—"On the Structure and Cause of Colour in the Nacreous Layer of Shells" (*Devon. Assoc. Trans.*, 1864); "On the Spicula of the Regular Echinoidea" (*Trans. Linn. Soc.*, 1865); "On a New Sponge, *Tethyopsis columnifer*" (*Quart. Journ. Micros. Sci.*, 1870); "On the Minute Structure of certain Hard Parts of the genus Cidaris" (*ibid.*, 1871): "Note on the Scalp of a Negro" (*Monthly Micros. Journ.*, 1873); "Note on the Calcareous Parts of the Sucking Feet of an Echinus, *Podophora atrata*" (*ibid.*, 1873); "Notes on *Bucephalus polymorphus*" (*ibid.*, 1875); "On the Lachrymal Gland of the Common Turtle (*ibid.*, 1877); "On a New Coral, *Stylaster stellulatus*, and Note on *Tubipora musica*" (*ibid.*, 1878); Note on an Abnormal *Amblypneustes griseus*" (*Journ. Linn. Soc.*, 1880); "On certain Organs of the Cidaridæ" (*Linn. Soc. Trans.*, 1877); "On Some Structural Features of *Echinostrephus molare, Parasalenia gratiosa*, and *Stomopneustes variolaris*" (*Journ. Roy. Micros. Soc.*, 1880); "On a Supposed New Boring Annelid" (*ibid.*, 1881); "On a Hermaphrodite Trout, *Salmo fario*" (*Journ. Linn. Soc.*, 1891); "On a Hermaphrodite Mackerel, *Scomber scomber*" (*ibid.*, 1891); "On Some Points in the Anatomy of *Heloderma*" (*Proc. Zool. Soc.*, 1891); "On a Specimen of the True Teeth of *Ornithorhynchus*" (*Quart. Journ. Micros. Sci*, 1891).

Supplementary Certificate.—Fullerian Professor of Physiology in the Royal Institution.

WILLIAM E. WILSON,

A gentleman who has devoted himself to astronomical research. In December 1870, he was engaged on the Total Solar Eclipse Expedition to Oran. In 1872 he built an astronomical observatory at Daramona and equipped it with a 12" reflector by Grubb. In 1881 he built a new observatory and equipped it with a 24" reflector by Grubb. In 1891 this was remounted and provided with electric control for stellar photography. Author of "A Method of recording the Transits of Stars by Photography" (Roy. Astron. Soc., 1889); "A New Photographic Photometer for Determining the Magnitudes" (*ibid.*, 1892); "On the Radiation of Heat from Sun Spots" (*Proc. Roy. Soc.*, vol. lv.); "The Absorption of Heat in the Solar Atmosphere" (*Proc. Roy. Irish Acad.*, 1892), in conjunction with Prof. Rambaut; "Experimental Investigations on the Effective Radiation from the Sun" (*Phil. Trans.*, 1894), in conjunction with Mr. P. L. Gray; "On the Temperature of the Carbons in the Electric Arc" (*Proc. Roy. Soc.*, 1892), in conjunction with Mr. P. L. Gray.

Supplementary Certificate.—In addition to the qualifications already set forth the following may be mentioned:—(1) Mr. Wilson has undertaken to carry out Experiments on Solar Radiation for the Committee of the British Association; (2) he has written a paper entitled "The Thermal Radiation from Sun Spots" (*Monthly Notices R.A.S.*, vol. lv., No. 8); (3) he has also written on "The Effect of Pressure of the surrounding Gas on the Temperature of the Crater of the Electric Arc" (*Proc. Roy. Soc.*, vol. lviii.).

HORACE BOLINGBROKE WOODWARD,

F.G.S., Geologist on the Geological Survey of England and Wales. Hon. Mem. Norfolk Nat. Soc. and Yorksh. Phil. Soc. Awarded the Murchison Fund by the Council of the Geological Society in 1885. On the staff of the Geological Survey since 1867, and author of the following memoirs :—"Geology of East Somerset and Bristol Coalfields" (1876); "Geology of the Country around Norwich" (1881); "Geology of the Country around Fakenham, &c." (1884); and of parts of five other memoirs; also of parts of sixteen sheets of the map, and of nine sheets of sections. Author of "The Geology of England and Wales" (1876 and 1887); of two papers in *Quart. Journ. Geol. Soc.* (1876, 1886); nine papers, &c., in *Proc. Geol. Assoc.* (1875-1889); of two Presidential Addresses to the Norwich Geol. Soc. (1879, 1880); of eleven other papers published by Norfolk and Somersetshire Societies (1874-1887); of nine papers in the *Geological Magazine*; of Reports on Coast Erosion (Brit. Assoc., 1885, 1889); and of Reports on Pliocene and Post Pliocene Beds to the British Sub-Committee of the International Geological Congress (1882, 1888),

Supplementary Certificate.—Since the above certificate was sent in, Mr. Woodward has been President of the Geologists' Association and of the Norfolk Naturalists' Society. He has also published various papers and memoirs, including the following:—"Formation of Landscape Marble" (*Geol. Mag.*, 1892); "Geological Zones" (*Proc. Geol. Assoc.*, 1892); "Oolitic Iron Ore in Raasay" (*Geol. Mag.*, 1893); "Memoir on the Lias of England" (Geological Survey, 1893).

WILLIAM PALMER WYNNE,

D.Sc. (Lond.), Assistant Professor of Chemistry in the Royal College of Science, South Kensington. Distinguished for his zeal and ability as an organic chemist. Author of "Action o. Sulphuryl Chloride on Acetorthotoluidide and Acetoparatoluidide, Mono-, Di-, and Tri-chlorotoluenesulphonic Acids," and "Note on the Constitution of Nevile and Winther's Orthotoluidenesulphonic Acid and of the Sulphonic Acids of Orthochlorotoluene and Orthobromotoluene" (*Trans. Chem. Soc.*, 1892). Joint Author with Prof. Japp of "Action of Aldehydes and Ammonia on Benzil" (*Trans. Chem. Soc.*, 1886). Joint Author with Prof. Armstrong of twenty-four papers in the *Proc. Chem. Soc.* from 1886-93 on Naphthalene and its Derivatives.

Supplementary Certificate.—Has submitted to the Chemical Society since 1893 papers on the Disulphonic Acids of Toluene and of Ortho- and Para-chlorotoluene (in conjunction with Mr. James Bruce); on the Six Dichlorotoluenes and their Sulphonic Acids (in conjunction with Mr. Alfred Greeves); and eleven communications on Naphthalene Derivatives (in conjunction with Dr. Armstrong). In their communications on Naphthalene (thirty-nine in all) made to the Chemical Society during the past ten years, Drs. Armstrong and Wynne have revised practically the whole of the Chemistry of Naphthalene in so far as relates to the formation of its Chlorinated and Sulphonated Derivatives, and, besides describing many new Derivatives, have placed beyond question the structure of the ten Di- and fourteen Tri-Chloronaphthalenes to which respectively all other Di- and Tri-Derivatives may be referred.

ON LIPPMANN'S COLOUR PHOTOGRAPHY WITH OBLIQUELY INCIDENT LIGHT.

IN the discussion which followed Prof. Lippmann's splendidly interesting communication to the Royal Society (April 23), on colour photography, I suggested the possibility of applying his method to the Röntgen X-light; but at the same time remarked that it might be found impracticable on account of the smallness of the specular reflection of the X-light from polished surfaces, unless at obliquities little short of 90°. Lord Blythswood's experiments, communicated to the Royal Society on March 19, seemed to prove decisively something of true specular reflection of X-light, incident on a plane mirror of speculum metal at 45°. Experiments, which he has since made by means of a concave mirror of speculum metal, have demonstrated beyond all doubt that there is regular reflection at nearly normal incidence; but they have also proved that the amount of regularly reflected light is exceedingly small in proportion to diffuse light caused to emanate from the mirror, by the incidence of X-light upon it. Experiments by Joly, of Dublin, have, I believe, proved somewhat abundant specular reflection of the X-light, at incidences little short of 90°, on surfaces of bodies transparent to ordinary light. And the extremely small refractivity of the photographic gelatine film for X-light, will allow incidences little short of 90° upon the metal mirror, to be used instead of the normal incidences which Prof. Lippmann has hitherto used. But for very oblique incidences the mercury mirror, with its surface fitted to

the not rigorously plane surface of the photographic film, would be unsuitable; and the plan, which Lord Rayleigh described in the discussion, of forming the film on a solid metallic mirror, might be substituted for it.

All things considered, it seems not improbable that Lippmann's process may be applied successfully to X-rays at nearly grazing incidences on metallic mirrors, and possibly even on non-metallic mirrors.

Suppose now, for instance, the directions of the incident and reflected rays to be inclined to the mirror at angles of ·1 of a radian ($5^\circ\!\cdot\!7$). The distance between the planes of stratification in the photograph would be ten times that which would be produced by the same light at normal incidence. Thus if, for example, the wave-length of the particular X-light used is 5×10^{-6} cms. (or one-tenth of that of green light), the photograph would show tints of from green to violet when viewed normally, or at less or more oblique angles, by Lippmann's ordinary arrangements.

It is quite possible, however, that when we know something of the composition of Röntgen light, we may find such great differences of wave-lengths[1] in it, and so much difficulty to obtain approximately homogeneous X-light by sifting through metal plates (as we sift ordinary visible light by coloured glasses), or by other means if other means can be found, that the experiment which I have suggested may fail on account of want of homogeneousness of the incident light.

But here, suggested to me by thinking of oblique incidence for the photographic light, is an illustrative experiment which (with variations of detail to facilitate realisation) cannot fail if Prof. Lippmann will think it worth while to try it. Place a point source of homogeneous violet light (wave-length 4×10^{-5} cms.) so near to the centre of the mirror and sensitive film that rays shall be received at all angles of incidence from zero up to 56° (being the angle of which the secant is 1·788). The thickness of each stratum will vary in different parts of the photograph in simple proportion to the secant of the angle of incidence, and in the centre it will be equal to the half wave-length. It will therefore vary from 2×10^{-5} in the centre to $3\cdot6 \times 10^{-5}$ at the circle of 56° incidence. This photograph, viewed or thrown on a screen as nearly as may be normally, according to Prof. Lippmann's ordinary procedure, will be seen as a complete spectrum in concentric circles, with violet in the centre, and red, of wave-length $7\cdot15 \times 10^{-5}$, at the circle of 56° incidence; but, if viewed by an eye placed at the position of the source of the violet light which photographed it, it will, according to the principles explained by Dr. Lippmann in his paper, be seen of uniform violet light throughout its whole area.

KELVIN.

[1] It is to be hoped however that, very soon, we shall have definite knowledge of wave-lengths of Röntgen X-light by diffraction fringes actually seen instead of estimates of their smallness from diffraction fringes not seen. I should explain that I am writing on the supposition which seems to me, after much correspondence with Sir George Stokes, to be exceedingly probable that Röntgen light is merely ordinary transverse-vibrational light of very short period. That its period is less than one-fifth that of green light seems well proved by the skilful experiments described by Perrin in *Comptes rendus*, January 27, 1896, p. 187; and by Sagnac, *Comptes rendus*, March 30, p. 783.

THE OBSERVATORY AT MONT MOUNIER.

THERE is no end to the generosity of M. Bischoffsheim. Not so very many years ago he endowed science with an observatory at Nice, and now again he has presented another, and this one is at the high altitude of over 8900 feet The observatory is situated on the summit of Mont Mounier, one of the peaks in the Maritime Alps. The advisability of having it at this spot was suggested by M. Bischoffsheim himself.

It was not till early in 1893 that the plans were worked out, but the observatory was sufficiently finished in August of the same year, to allow observations of Venus to be made before the planet passed into its inferior conjunction.

Mont Mounier Observatory (altitude over 8900 feet).

The buildings consist of a house for the astronomer and his assistant, the actual observatory, which has a revolving metallic dome (26 feet in diameter), and a wooden hut, used as workshop or depôt. The house and actual observatory are united by a passage, which is indeed a necessary arrangement, on account of the very severe weather, and the snow, which sometimes lies thickly on the ground.

The observatory is a branch of the one at Nice, and at the time that important observations were being made at Nice, for the purpose of verifying M. Schiaparelli's discoveries on the rotation of the planet Venus, they were simultaneously being carried on at Mont Mounier by M. Perrotin, and with most successful results.

M. Bischoffsheim suggested that the observatory should be a meteorological station; it has therefore been furnished with Richard's recorders, and instruments for ascertaining the temperature, pressure, and other conditions of the air.

Nor is the observatory now isolated. For some weeks the house has been connected by telephone to Beuil, the nearest village with a telegraph office, a distance of five miles. This was also done at the expense of M. Bischoffsheim. It will therefore be possible to send daily reports to the central meteorological office of the observations made on Mont Mounier.

There can be no doubt that the Mont Mounier observatory, started under such favourable conditions, and so well supplied with instruments, will considerably assist in the advance of science.

DR. ADALBERT KRÜGER.

ASTRONOMERS in all observatories and of all nationalities will have learned with regret of the death of Dr. Krüger, the Director of the Kiel Observatory, but who, perhaps, will be more generally recalled as the editor of the *Astronomische Nachrichten*, and gratefully remembered for his services to that journal. From the time that Schumacher, under the auspices of the Danish Government, started the *Nachrichten*, no astronomical journal has proved itself so indispensable, both as a means for the publication of observations and the dissemination of astronomical knowledge, or contributed more to its advance and progress. For that large class of observations of which early publication is its greatest value, but the details of which are a weariness to most editors, the *Astr. Nach.* has stood unrivalled, and its general conduct has wisely preserved the broad lines on which it was originally established. And with the progress of time, as the eagerness of observers has increased with their numbers, Prof. Krüger has recognised the necessity of still more rapid means of communication, and by adding to his manifold duties that of the management of the *Bureau central des dépêches astronomiques*, he has made still further demands on our gratitude, for the ease and certainty with which astronomical discoveries are sent all over the globe, and made available to those who take advantage of the system he has elaborated. Prof. Förster, of Berlin, we believe, early advocated the plan which has proved itself so useful, but the details of the management have been wisely left in the hands of the Director of the Kiel Observatory.

But these services to science, rendered continuously from 1880, when the death of Dr. Peters made vacant both the positions which Dr. Krüger has since filled so admirably, should not put out of sight the fact that he has been both a skilled observer and an ardent astronomer. It is sufficient to recall here his more prominent services, such as the share he took with the late Dr. Schönfeld in the observation of the zones for the *Durchmusterung* at the Bonn Observatory: a work at first voluntarily undertaken on his part, but later in regular and active co-operation with Argelander and Schönfeld. Here, too, during an absence of Dr. Winnecke, which prevented the heliometer being used, he began and carried to a successful issue the determination of the parallax of 70 Ophiuchi, in two very accordant series.

In 1862 Dr. Krüger was appointed Director of the Helsingfors Observatory, in which the instrumental equipment was probably insufficient. There he busied himself with an inquiry into the orbit of Themis, with the view of obtaining a more accurate value of the mass of Jupiter, which the continued observation of that planet is likely to afford. The result, published in the *Proceedings* of the Finnish Society of Sciences, was to show that Bessel's value of the mass of Jupiter, the then received value, required to be increased by the 68/100,000 part, and to give a value intermediate between that of Airy and Bessel, as derived from the motions of the satellites.

From Helsingfors, Dr. Krüger went to the Observatory at Gotha, where he stayed five years, leaving that city to take up his final position at the well-equipped Kiel Observatory, in 1880. For after the termination of the Danish dominion in the Elbe Duchies, the observatory had been enriched by the instruments from the old observatory at Altona, and had been brought into closer relations with the university. This position naturally carried with it the editorship of the *Nachrichten*, to which allusion has already been made. It is true that since the journal has been under his care, the words "Unter Mitwirkung des Vorstandes der Astronomischen Gesellschaft" have appeared on the title-page, but we imagine Dr. Krüger has enjoyed a free hand in its management, with beneficial results to the journal and to his own reputation. In his capacity as Director, he has published many observations of comets, and prepared, or had prepared under his own eye, the orbits and ephemerides of many of these bodies. These computations have been occasionally enriched by notices of a mathematical character, such as the effect of perturbations by planets near the sun. He has also occasionally given original observations of stars observed with comets, and in many useful, if not brilliant, ways, he has shown his capacity as a Director of an observatory. His career has been marked by an energy and industry, to which might be applied the words of Schiller, "Beschäftigung die nie ermattet, die langsam wirkt doch nie zerstört."

NOTES.

THE first of the two annual conversaziones of the Royal Society was held last night, as we went to press.

THE Council of the British Association have resolved to nominate Sir John Evans, K.C.B., Treasurer of the Royal Society, for the presidency at the meeting which will be held next year in Toronto.

THE following fifteen candidates were selected on Thursday last by the Council of the Royal Society, to be recommended for election into the Society:—Sir G. S. Clarke, Dr. J. N. Collie, Dr. A. M. W. Downing, Dr. F. Elgar, Prof. A. Gray, Dr. G. J. Hinde, Prof. H. A. Miers, Dr. F. W. Mott, Dr. J. Murray, Prof. K. Pearson, Rev. T. R. R. Stebbing, Prof. C. Stewart, Mr. W. E. Wilson, Mr. H. B. Woodward, Dr. W. P. Wynne. The qualifications of the candidates will be found in another part of this issue.

THE Surinam Toads (*Pipa americana*), at the Zoological Society's Gardens, have recommenced breeding this year, and two of the females may now be seen with their backs covered with cells, in each of which an egg is located. The hitherto unexplained mode in which the eggs are transferred into their cells has been discovered, and the secret was divulged at the last scientific meeting of the Society.

AN unnamed donor has given Harvard University 100,000 dols. to found a Chair of Comparative Pathology, the only one of the kind in any leading American University.

THE generous hospitality always dispensed to British men of science by continental Governments beggars anything ever done officially in England to welcome foreign visitors distinguished in science. We have already notified that the summer meetings of the Institution of Naval Architects will be held this year in Hamburg on Monday, June 8, and the following day. On Wednesday, June 10, the meetings will be transferred to Berlin, on the invitation of the Imperial German Government, and will be continued there during the remainder of the week. With a public spirit which should put British steamboat companies to shame, the Hamburg-American Company have generously offered to take the members over in a body from Tilbury to Hamburg in their twin-screw Transatlantic liner the *Fürst Bismarck* free of charge. The steamer will start either late on Saturday night, June 6, or else early on Sunday morning, June 7, and will arrive in Hamburg in about twenty hours after its departure. The meetings are receiving the warmest support from the Imperial Government, and the arrangements in Berlin are being carried out by the Imperial

Ministry of the Interior and the Imperial Ministry of Marine. A programme of exceptional interest for the instruction and entertainment of the members is already in course of preparation. The meetings for the reading and discussion of papers will be held in Hamburg in the Bürgerschafts-Saal in the building of the Patriotische Gesellschaft, and in Berlin in the large hall of the Technical High School. Papers have already been promised by the following German members of the Institution:—Herr Dietrich (Privy Councillor), Constructor-in-Chief of the Imperial German Navy, Herr F. Laeisz, President of the Chamber of Commerce of Hamburg, and by Mr. B. Martell and Dr. F. Elgar, amongst other home members of the Institution. It is hoped that the members of the Institution will do all in their power to assist in doing honour to their most hospitable hosts by attending in large numbers.

IT is with sad feelings that we read of the elaborate preparations that have been made abroad to celebrate the centenary of the discovery of vaccination, and reflect that nothing is being done in England to honour Jenner's memory. The *British Medical Journal* says:—On May 14, 1796, Edward Jenner performed the first successful vaccination. The centenary of that event is to be celebrated in a manner befitting its importance in the history of mankind in Germany, Russia, and the United States. In Berlin preparations have been made under the direction of a Committee which includes Profs. Virchow, Gerhard, von Leyden, Robert Koch, von Bergmann, Koenig, Heubner, Langerhans, Proskauer, and other leading representatives of medical and sanitary science, for a great meeting on May 14 in honour of the discoverer of vaccination. There is also to be an exhibition in the Medicinische Waarenhaus (Friedrichstrasse, 108 I, Berlin, N.) of literature, old and new, relating to vaccination, portraits, medals, instruments, &c. In St. Petersburg, the Russian Public Health Society, the Honorary President of which is the Grand Duke Paul Alexandrovitch, has, with the sanction of the Czar, organised a commemoration festival on a still larger scale. On May 14 a "general and solemn" meeting will be held in honour of the discovery. Four prizes will be awarded for the best works on vaccination. An exhibition of objects connected with vaccination will be held. A Russian translation of Jenner's writings, with a biography and portrait, and reproductions of his drawings, will be published under the editorship of Dr. W. O. Hubert. The Council of the Society, with the help of the Government, of provincial and municipal administrative bodies, of scientific societies, and private medical practitioners, has collected materials for a history of small-pox and vaccination in Russia, which will appear at the same time. In the United States arrangements for the celebration of the centenary have been made by a conjoint Committee appointed by the American Medical Association and the American Public Health Association. The celebration is fixed for May 7, the third day of the meeting of the American Medical Association at Atlanta, and the whole of that day will be occupied by addresses and discussions on Jenner and vaccination. Truly is a prophet without honour in his own country when that country is England.

SIR JOHN GORST stated in the House of Commons, on Thursday last, that arrangements are being made to open the Geological Museum in Jermyn Street on Sundays, but the continuance of the practice will depend upon how far the number of visitors appears to justify it.

THE *Botanical Gazette* has passed into the possession of the University of Chicago. It is not, however, to be the botanical organ of the University, but will be freely open, as before, to botanists of all parts of the globe. The object of the change is to secure permanence and possibility of development. The old editors, Prof. J. M. Coulter, Prof. C. R. Barnes, and Prof. J. C. Arthur, remain.

WE learn from the *Botanical Gazette* that the recent "Culver gift" of one million dollars to the University of Chicago for biological endowment has resulted in the establishment of a Department of Botany, in which Dr. John M. Coulter has accepted the head professorship. A large building, to be known as the "Hull Botanical Laboratory" has been planned, and its erection will soon be begun. The four stories of this building will contain ample space for lecture-rooms, libraries, laboratories, and private research rooms for morphology, physiology, and taxonomy. Above the fourth story a large roof-greenhouse will supply an abundance of living material under all conditions As the building will not be completed before April 1897, the full botanical staff will not be organised before the autumn of that year.

DURING the last few weeks some experiments in sea-fish hatching have been carried on at the Port Erin Biological Station, for the Lancashire Sea Fisheries Committee. Prof. Herdman has erected a series of wooden tanks and sand filters, through which the water is passed by the action of a water-wheel worked by the fresh-water tap. The Sea Fisheries steamer, *John Fell*, spent several days at Port Erin trawling for the spawning fish. The ova were fertilised on board, and then conveyed to the tanks. The first batch of young fish ("witches" or white soles) were hatched out on April 29, exactly seven days after fertilisation; and there are now in the tanks, far advanced in their development, lemon soles, witches, and grey gurnards. The work, so far, has been carried out successfully, and the result ought to encourage the Lancashire Committee to realise their project of erecting a sea-fish hatchery near the principal spawning grounds of the Irish Sea.

WE regret to note the death of the Rev. W. C. Ley, on the 22nd ultimo, at the age of fifty-five. He was ordained in 1863, and in 1874 was presented by the Lord Chancellor to the rectory of Ashby Parva, near Lutterworth, which he held until 1892. Mr. Ley had for many years paid special attention to the study of the clouds and the movements of upper air-currents. In 1872 he published an important work on "The laws of the winds prevailing in Western Europe," in which he showed how the preparation of synchronous weather charts, and the accumulating testimony of the universality of the law generally known as Buys Ballot's, connecting wind conditions with the distribution of barometric pressure, had proved some accepted weather theories to be erroneous, and had rendered necessary a new investigation of the general laws. In the year 1879 the Meteorological Council appointed him Inspector of their English stations, and in the following year they requested him to prepare a manual to facilitate the study of the weather in connection with the information supplied by their Daily Weathe Reports. This work, entitled "Aids to the study and forecast of weather," explains clearly the relations of weather conditions to the distribution of areas of both high and low atmospheric pressure. His most recent work, "Cloudland, a study on the structure and characters of clouds," published in 1894, was prepared for press by his son, owing to the serious illness of the author. It embodies the results of his life's work in connection with this subject; the nomenclature is probably too advanced for general adoption, but the treatise contains much valuable information upon the classification of the clouds and the origin of their formation, as well as upon the important bearing of cloud observation on the prognostication of weather. Many papers of minor importance were contributed by Mr. Ley to the *Journal* of the Royal Meteorological Society.

MR. F. E. BEDDARD, F.R.S., gave the first of a course of lectures on the animals in the Zoological Society's Gardens, in the

lecture-room at the Gardens, on Saturday last. The lecture was of an introductory character, explaining the position of Mammals amongst the Vertebrates, and their classification into three main divisions. The extinct Multituberculata and their possible relation to the Monotremes were also spoken of. The course will be continued every Saturday at 4 p.m. until July 4.

At the International Meteorological Conference at Munich, in 1891, a Committee was appointed to consider the question of concerted observations on the direction of motion and the height of clouds. The report of this Committee was made to the International Meteorological Committee at their meeting at Upsala in 1894, the result being that all countries were invited to take part in the investigation of the upper currents of the atmosphere, by means of cloud observations, which are to commence on the 1st prox., and be continued for a year at least. For the use of observers who adopt the international classification recommended at Munich, a standard cloud atlas has been prepared, consisting of about thirty coloured pictures, and is now in course of publication in Paris; while persons who do not adopt that classification are at liberty to use the nomenclature employed in their country. The observations of motion may be made without instruments, or with simple nephoscopes; but the measurements of altitudes require the use of theodolites or photogrammeters, and can only be carried out at regular observatories. Descriptions of the methods to be employed have been published by Dr. Hildebrandsson, of Upsala, and others, and also in *Das Wetter* for February last. Various countries in Europe, the United States, and Java, have undertaken to make the more difficult instrumental observations, and it is recommended by the International Meteorological Committee that the observations from each country should be eventually published *in extenso*, as a separate publication.

The south-east of Europe is one of the most pronounced seismic districts of the world, and it is gratifying to learn that the earthquakes there are to receive the attention they deserve. In a previous note, we have referred to the work of the seismological section of the meteorological observatory at Constantinople, and we have now to announce the formation of a similar section of that at Athens. This has been placed under the charge of Dr. S. A. Papavasiliou, who is well known for his careful investigation of the Locris earthquakes of 1894. Information with reference to Greek earthquakes has indeed been transmitted to the observatory since 1893, and the accounts of these shocks will be published later on. It is only, however, within the last few months that an attempt has been made to organise regular observations. At the observatory of Athens two Brassart seismoscopes of a simple character have been erected, one of them giving the time of occurrence of each shock felt there. The officials at the meteorological stations and telegraph offices (twenty-three in number) have been instructed to make observations, and forward their registers to the observatory; and, commencing with this year, a monthly seismological bulletin has been started. The number for January has just been published, and tends to confirm Dr. Papavasiliou's estimate that hardly a day passes without an earthquake being felt somewhere in Greece, for no less than thirty-four are recorded as occurring during January alone. The most interesting is an after-shock, on the 24th ult., of the great earthquakes of April 20 and 27, 1894, showing a still further displacement of the epicentre towards the W.N.W. along the great fault formed at the time of the last-mentioned shock.

In Tunbridge Wells, on Saturday last, a congress was held of the naturalists of the South Eastern District, with the object of forming a Union of Natural History Societies for mutual help and investigation. The idea originated with Dr. George Abbott, who carried out all the preliminary details for the congress. The first part of the day was taken up by the delegates inspecting the geological features of the town, and after luncheon they assembled in the Pump Room, where the congress was held, under the chairmanship of the Rev. T. R. R. Stebbing, President of the Tunbridge Wells Natural History and Philosophical Society, and whose name is amongst those selected for election into the Royal Society. A large number of delegates from important Natural History Societies of the south-eastern counties of England were present. Dr. Abbott described how the Union could be of assistance to science. Each Society in the Union would offer its members (1) free admission to their lectures and excursions; (2) copies of their Transactions; (3) the use of their library; (4) assistance in naming of specimens, and with the formation of school museums. The corresponding members, in return, would be asked to (1) forward surplus natural history specimens to their Societies' Museum; (2) supply prompt information on the following subjects: (*a*) new geological sections: (*b*) details of wells, borings, springs, &c.; (*c*) finds of geological and antiquarian interest; (3) answer such questions as the British Association or the local Society may require; (4) keep an eye on historic buildings; (5) assist the Selborne Society in carrying out its objects. Such appointments would be certain to stimulate individual investigation in the parishes, and useful scientific work would be done. After a discussion, the following resolution was adopted: "That the delegates from various scientific Societies of Surrey, Kent, and Sussex, assembled in congress at Tunbridge Wells on April 25, 1896, agree that the congress shall meet annually, by invitation, at the home of one or other of the associated Societies." The Rev. T. R. R. Stebbing was elected President of the Union, and Dr. Abbott, Secretary. It was agreed that Surrey, Kent, Sussex, Middlesex, and Hampshire should be included within the scope of the Union's operations.

An extremely interesting series of experiments on the action of a powerful magnetic field on the kathodic rays in Crookes' or Hittorf's tubes, is described by Herr Kr. Birkeland in the *Elektroteknisk Tidsskrift* (Christiania). These experiments prove that in such a field, the kathode rays are strongly deflected in the direction of the lines of force, and can even be concentrated on to the surface of the tube until the glass melts. Moreover, the evidence suggests that the rays which emanate from one and the same kathode fall into groups, of which the physical constants are connected by some definite law, just as are the frequencies of the different tones emitted by a vibrating rod. The investigation has an important bearing on the theory of the Aurora Borealis. The Danish meteorologist, Herr A. Paulsen, is of opinion that the aurora owes its origin to phosphorescence of the air produced by kathodic rays in the upper strata of the atmosphere, and Herr Birkeland suggests that the earth's magnetism may be the cause of this phosphorescence becoming intensified in the neighbourhood of the terrestrial poles.

Under the editorship of Mr. F. S. Macaulay, of St. Paul's School, the first number of a new series of *The Mathematical Gazette* has just been issued by the Association for the Improvement of Geometrical Teaching. The size of the pages has been changed from quarto to demy octavo; by this change the *Gazette* has been brought into uniformity with the leading English and continental mathematical and other scientific octavo publications. The present number contains articles on "The Geometrical Method," by Dr. J. Larmor, F.R.S.; "Annuities treated without Progressions," by Dr. G. H. Bryan, F.R.S.; and "The Conic determined by Five Given Points," by the editor; together with a large number of problems and solutions. The *Gazette* deals exclusively with points of interest in the history and teaching of elementary mathematics (not extending beyond the Calculus), and it thus covers a somewhat different range of

subject-matter to any other mathematical journal in the United Kingdom.

MESSRS. DULAU AND CO. have just issued a catalogue (No. xv.) of works on geographical botany, containing more than four thousand titles, offered for sale by them.

THE Appendix of "Quain's Elements of Anatomy" (Longmans, Green, and Co.), which completes the tenth edition of the work, has now been published. The subject, "Superficial and Surgical Anatomy," is treated by Profs. G. D. Thane and R. J. Godlee.

WE learn from the current (and final) number of the *American Meteorological Journal*, that the New England Meteorological Society has been dissolved. It was formed in Boston, in June 1884, to promote the study of atmospheric phenomena in the New England States, and to establish systematic observation. It has done much useful work, especially relating to rainfall, thunderstorms and range of temperature, the results of which have from time to time been published in the above-named journal. The system of regular meteorological observations and the publication of a monthly bulletin were transferred to the New England Weather Service, in connection with the Washington Weather Bureau, several years ago.

THE Rebman Publishing Company have issued the first number of the *Archives of Clinical Skiagraphy*, by Mr. Sydney Rowland, being the commencement of a series of collotype illustrations, with descriptive text, illustrating applications of the new photography to medicine and surgery. In an introduction Mr. Rowland gives a brief account of Röntgen's discovery, and describes the great advantages obtained by the use of the form of Crookes' tube known as the focus tube, devised by Mr. Herbert Jackson. The excellent results obtained by British investigators working with X-rays are almost entirely due to the introduction of this form of tube. As to the constitution of fluorescent screens, Mr. Rowland agrees with the conclusion arrived at by Mr. Jackson after a systematic examination of numerous substances, viz. that the best salt to use is platinocyanide of potassium. The plates included in the present number of the *Archives* show the skeleton of a full-grown child, aged three months (exposure fourteen minutes), a needle embedded in a finger (exposure two minutes), knee-joint, from a case of multiple exostosis (exposure nine minutes), and hand of same case (exposure three minutes), wrist and forearm showing syphilitic disease of radius (exposure six minutes). The illustrations may be taken as an indication of how the Röntgen photography is able to supplement diagnosis in all cases of bony disease. It is really astonishing to think that, though Prof. Röntgen's discovery is but a few months old, it has already taken its place among the approved and accepted aids to diagnosis, and a publication has been started to deal with its developments in medicine and surgery.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♂) from India, presented by Mr. E. Turnham; a Fennec Fox (*Canis cerdo*) from Egypt, presented by Mr. J. G. Mackie; a Mexican Skunk (*Mephitis macrura*) from Mexico, presented by Mr. Henry Heath Cochrane; a Brahminy Kite (*Haliastur indus*) from India, presented by Mr. A. Kemmis-Betty; an African Tantalus (*Tantalus ibis*), a Leopard Tortoise (*Testudo pardalis*) from East Africa, presented by Captain Dugmore; a Canary Finch (*Serinus canarius*) from Madeira, presented by Mr. H. B. Hewetson; a Great Wallaroo (*Macropus robustus*, ♀), a Gould's Monitor (*Varanus gouldi*), a Black and Yellow Cyclodus (*Cyclodus nigroluteus*) from Australia, a Yellow-headed Conure (*Conurus jendaya*), two Brazilian Tortoises (*Testudo tabulata*) from Brazil, five Meyer's Parrots (*Pœocephalus meyeri*), two Alario Sparrows (*Passer alario*) from South Africa, a Brown-throated Conure (*Conurus æruginosus*) from South America, deposited; a Chimpanzee (*Anthropopithecus troglodytes*, ♀) from West Africa, a Red-naped Fruit-Bat (*Pteropus funereus*), —— Bandicoot (*Perameles* ——) from Australia, two Spotted Tinamous (*Nothura maculosa*) from Buenos Ayres, purchased.

OUR ASTRONOMICAL COLUMN.

THE PLANET MERCURY.—An unusually good opportunity of observing the planet Mercury with the naked eye, or with an opera-glass, will be afforded about the middle of the present month. The planet will be at its greatest eastern elongation on May 16, when it will be 22° from the sun, and will remain above the horizon for two hours and a quarter after sunset. At this time the apparent diameter of the planet will be 8″, and about 0·4 of the disc will be illuminated. On May 14, at 6 p.m., the planet will be in conjunction with the moon, Mercury being 2° 24′ to the south; at 9 p.m. on the same evening, the crescent of the two days' moon will be about 3° N.N.E. of the planet.

COMET SWIFT 1896.—The following continued ephemeris for the new comet is from revised elements computed by Dr. Schorr for Berlin midnight:—

	R.A. h. m. s.	Decl. ° ′	Brightness.
May 8	2 12 41	+62 58·1	
10	1 58 52	64 46·1	0·35
12	1 44 41	66 17·4	
14	1 30 19	+67 33·9	0·26

The unit of brightness is that on April 16. The comet was easily visible in a three-inch telescope on April 30, when the computed brightness was 0·7.

NEW DIVISIONS OF SATURN'S RINGS.—In the current number of the *Comptes rendus*, M. Flammarion gives particulars of some very interesting observations of Saturn's rings which have been made at his observatory by M. Antoniadi during the last month. Between the Cassini division and the Crape ring, three new divisions of the ring have been noted. The darkest of these, which is easily visible when the air is transparent, nearly bisects the inner bright ring; the fainter divisions, one on each side, are only observed with difficulty. The inner bright ring is thus divided into four zones, gradually darkening towards the planet.

This is by no means the first time that divisions of this kind have been recognised. Herschel, De Vico, Bond, Hall, and others, have in turn observed or suspected them, but Cassini's division is the only one which seems to be certainly permanent. M. Flammarion concludes that the fainter divisions observed on the rings are variable, and possibly dependent upon the varying attractions of the eight satellites upon the meteoritic particles of which the rings are composed.

DETERMINATION OF THE GENERAL BRIGHTNESS OF THE CORONA.—In the current number (vol. vi. No. 6) of the *Journal* of the British Astronomical Association, Mr. Joseph Lunt suggests a method by which a numerical value could be obtained for the general photographic intensity of the light of the corona during a total solar eclipse.

The method consists in photographing a "sensitometer window," consisting of twenty-five numbered squares of graduated opacities (like a Warnerke's sensitometer, but with different values). The opacities are so adjusted that an exposure of ninety seconds to full moon-light, which approximates to the coronal light, should yield a negative showing the figure 12. The negative could be obtained either by direct contact with the "sensitometer window" (as in lantern-slide making), or by forming an image of the "window" on the plate by means of a lens. The plates could be standardised by exposure to any standard artificial light or to full moon-light, according to Mr. Maunders' suggestion, in order to reproduce the precise illumination of the sensitometer window given by the corona. The conditions of development of the negatives for comparison should be identical, and the plates used should all be of identical sensitiveness.

The apparatus required is very simple, consisting of a box of square section, about three feet long, closed at one end by a ½-plate dark slide, and at the other by the ½-plate sensitometer,

screened by a dew-cap. A diaphragm in the middle carries a lens to form an image of the sensitometer on the plate. A simpler way is to obtain the negative by direct contact, in which case the sensitometer should be screened from the general sky illumination of the horizon.

OBSERVATIONS ON ISOLATED NERVE.

THE work which Dr. Waller has recently summed up in the Croonian Lecture, is an experimental study of the influence of reagents upon excitable—that is to say, living—protoplasm. The choice of nerve as the most convenient form of living matter in such an inquiry is justified by the consideration that nerve, as is now generally admitted, is practically inexhaustible. That nerve fibre, apart from its end organs, is peculiarly responsive to even slight changes of chemical condition; and, further, that with this tissue there is the advantage of a wide and regular range between minimal and maximal effects. A previous research had shown (*Brain*, 1895) that in nerve, contrary to what obtains in muscle, stimulus and response, cause and effect are proportional, the curve expressing their relation to one another being a straight line. Probably, however, the autographic records of these nerve experiments will afford the most convincing argument for the employment of nerve fibre as a test tissue.

The main principle upon which the inquiry is based is the proposition of Du Bois-Reymond and of Hermann, that disturbed protoplasm is electro-negative to the normal; that excited is electro-negative to resting protoplasm. The excised and still living nerve of the frog gives off to the galvanometer a current, called by Hermann "the current of inquiry," which current, on stimulation of the nerve, undergoes a reversal of direction, the "negative variation," or "current of action." Supposing the nerve to be set up so that the current of inquiry is manifested as a northward deflection of the galvanometer (the arrangement followed in these experiments), the negative variation will be south. It is the magnitude of this negative variation which is taken as the index to the magnitude of chemico-physical change aroused in the nerve under various chemical conditions. To a series of stimuli of uniform intensity and duration, given at regular intervals, the nerve responds by a series of uniform deflections or negative variations, which persist for an indefinite time in the absence of modifying agents. A short series of such normal deflections precedes, in these experiments, the application of a reagent, after which, the stimuli being continued, the effect of the drug appears as increase, diminution, or abolition of the negative variations, as the case may be. The galvanometer deflections are recorded on a slowly-moving photographic plate.

The nerve, it should be said, is enclosed in a moist chamber, and rests on two pairs of electrodes, those leading off to the galvanometer, and a pair of wires from an induction coil by which the stimulations are sent in; these consist of weak tetanising currents of 8 secs. duration, given at minute intervals. Where gases are used, they are simply driven through the nerve chamber by pressure; where drugs in solution are employed, the nerve is removed from the electrodes and bathed in the solution for one minute.

Such is, briefly, the method employed. Of the results hitherto obtained, those which relate to the action of anæsthetics upon living matter will have a wide interest from their bearing upon a great practical issue. There is, of course, no question of the crude application of laboratory experience to therapeutics; yet a test so delicate and regular in its working, cannot but have its value in any estimate of the relative advantages and perils of various anæsthetic agents.

The comparative action of carbon dioxide, of ether, and of chloroform has been studied at length. All these in small quantity produce primary augmentation, and a pretty experiment consists in simply blowing through the nerve chamber, when the characteristic rise is produced by the carbon dioxide contained in the expired air. In larger quantity carbon dioxide gives abolition or diminution (Figs. 5 and 6); several minutes may elapse during which there is no response to the regularly repeated stimuli, but the abolition is not permanent, the deflections reappear, attain to, and for a time surpass their normal size. Ether vapour produces a more prolonged anæsthesia, followed by complete recovery of excitability (Fig. 1). Chloroform vapour gives a still more prolonged and often final abolition, recovery, where it takes place, being much less complete than in the case of ether (Fig. 2). Carbon dioxide added to chloroform counteracts the toxic effect and renders it more perfectly anæsthetic—that is to say, there is complete abolition followed by complete recovery.

Of the many other gases tried, oxygen (Fig. 3), carbon monoxide, and nitrous oxide (Fig. 4) give little or no effect, anæsthesia by the last is probably a carbon dioxide effect.

Passing by many groups of chemical substances of which the action has been tested, we may note merely that the study of the comparative action of haloid salts brings out with much clearness the analytical value of the method.

In regard to the acids, a fundamental question to be determined was as to whether their action upon living protoplasm was in proportion to acidity or to avidity. The answer obtained is to

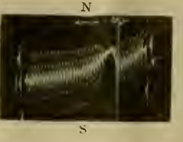


FIG. 1.

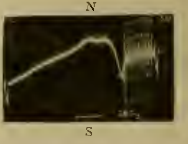


FIG. 2.

the effect that acidity is the chief determining factor. Three acids of widely different avidities, viz. nitric, sulphuric and acetic, have approximately equal effects at the same acid strength. Yet acids have also their specific action, a comparison of, for instance, lactic and oxalic acids of equal strength shows the former to be far more powerful than the latter.

But the most interesting result of these experiments, from the purely physiological point of view, is the demonstration of the evolution of carbon dioxide in the nerve itself. As the chief terminal product of protoplasmic activity carbon dioxide had received a large share of attention, and its influence had been recognised as giving the clue to a curious puzzle with regard to the nerves. In the earlier experiments, when a frog was killed, one sciatic nerve was removed for use, while the other was

FIG. 3. FIG. 4.

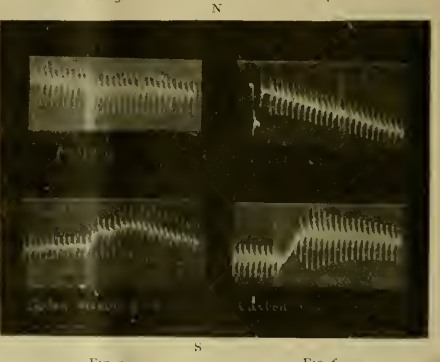


FIG. 5. FIG. 6.

The light band across the plates marks the passage of the gas through the nerve chamber.

left in the body until required. It was noticed that the second nerve was usually more excitable than the first, and when, as sometimes happened, a nerve had been left in the body all night, the negative variation was often a very large, though a declining one. To recognise that this augmentation was due to carbon dioxide given off by the surrounding tissues, was to have a fresh example of the delicacy of nerve as an indicator of the presence of the gas; and the question suggested itself: Supposing carbon dioxide to be evolved during nerve activity, *i.e.* prolonged tetanisation, ought not its presence to be marked by the now familiar augmentation of the negative variation? To test this, recourse was had to a very simple experiment; but before making it, a forecast of its probable course was drawn upon a

black-board. The usual series of normal deflections having been recorded, tetanisation was to be prolonged for five minutes, with the result that the succeeding variations would show an increase which would gradually sink back to the normal. In the actual experiment these anticipations were exactly fulfilled.

Further experiments upon nerve in different conditions (the particulars of which cannot here be described) showed the effect of carbon dioxide as still coinciding with that of prolonged tetanisation, such effect consisting primarily in an augmentation of the negative variation; hence the conclusion is drawn that tetanised nerve evolves carbon dioxide.

In favourable conditions augmentation of the negative variation may be produced by the series of brief tetani employed in the rhythmic excitation of the nerve, when the effect closely resembles the well-known "staircase" phenomenon occurring in contractile tissue. Dr. Waller leaves it an open question whether or no the phenomenon is of carbon dioxide production in muscular as well as in nervous tissue.

Of other sub-positive considerations touched upon, one of chief interest is the surmise as to the functional and chemical relations between grey axis and white sheath in a medullated nerve fibre. The stability of nerve is that of perfect compensation, not that of slowness or absence of change; and it is probable that the investing white sheath supplies the means of rapid repair to the functional grey matter.

It is perhaps not too much to hope that an elucidation of the processes of assimilation and dissimilation will be among the gains to our knowledge of living matter brought about by this new method in the immediate future. S. C. M. S.

THE INSTITUTION OF MECHANICAL ENGINEERS.

THE annual Spring Meeting of the Institution of Mechanical Engineers was held last week on the evenings of Wednesday, April 29, and Friday, May 1. The President, Mr. E. Windsor Richards occupied the chair on both occasions. The meetings were held in the theatre of the Institution of Civil Engineers, lent by the Council of that body for the purpose. The new buildings, which are now being erected for the Institution of Mechanical Engineers, are fast progressing, and probably the present year will be the last during which the latter Society will be dependent for a meeting-place upon the hospitality, always so freely accorded, of the older Institution.

The agenda for the meeting contained two papers, as follows:—

(1) "Steel Steam Pipes and Fittings, and Benardos Arc Welding in connection therewith." By Mr. Samuel MacCarthy, of London.

(2) "Research Committee on the Value of the Steam Jacket. Experiment on a Locomotive Engine." By Prof. T. Hudson Beare and Mr. Bryan Donkin.

The first business of the meeting, the usual formal proceedings having been disposed of, was the reading of his address by the President. Mr. Richards, as is well known, is a prominent steel manufacturer, having held important positions in steel works both in South Wales and in the Cleveland district. As might have been expected, therefore, he dealt more with the raw material which engineers use, rather than the methods of working it up; that is, mechanical engineering proper. It would be ungracious to find fault with the address, which must have involved much labour in its preparation, but the members of the Institution could hardly but feel a little disappointed that the President did not deal more with the machinery used at iron and steel works, rather than with the form of blast furnaces and their products. Mr. Richards' wide experience would have made of the greatest value his remarks on rolling-mills, rolling-mill engines, blowing engines, and many other pieces of machinery which are strictly examples of mechanical engineering used in iron and steel works. However, he elected to confine his attention more particularly to blast furnaces, and his remarks on the subject, although perhaps more in keeping with the other technical society, of which he is a yet more prominent member, the Iron and Steel Institute, were nevertheless of considerable interest. Mr. Richards referred to the delegation organised last year, through the British Iron Trade Association, to visit Belgium and Germany, with a view to ascertaining how it was that these countries were able not only to compete with us in neutral markets, but were also able to sell their products even in our own markets. As the address said, the inquiry undertaken by the delegation involved great labour, and some of our readers may perhaps remember that at the time it stirred up some very angry feelings; the Germans specially resenting what they considered an intrusion into their country. We have not space to follow the President in his discussion upon blast furnace practice in various countries, though it may be generally stated that the Americans show an amount of intelligence and energy in their iron and steel works, which is not surpassed and hardly equalled in any other country. Indeed in blast furnace practice the United States may justly claim to take the leading position in the world, not even excepting ourselves. At the present time near Pittsburgh there is being erected an addition to the Duquesne Works, which will cost about £600,000. Four blast furnaces of a height of 100 feet are being erected, together with the necessary blast engines and other plant. A production of 500 tons of pig-iron every twenty-four hours is expected from each furnace, thus bringing the total product for the year up to the enormous amount of 180,000 tons. Quick working generally means short life in a blast furnace, as in so many other things, and it has been often contended by English iron-makers that the slower working followed in this country is more profitable. If, however, it be allowed that the lining of the new American furnaces only lasts for four years, no less than 700,000 tons of pig-iron will be obtained in that time; a quantity which, as the address pointed out, an English furnace would require fourteen years to produce. Putting aside the question of furnace lining and renewing, it will be easily seen the large advantage a system of quick working gives in respect of labour, establishment charges, and, in fact, all the items that go to make up the cost of producing pig-iron, excepting the raw material. Under these circumstances it is hardly to be wondered at that the American output in the iron trade is advancing with such gigantic strides. Mr. Richards stated that generally in America the whole labour cost per ton of Bessemer pig-iron, is from 80 cents to 1 dol., and it is expected that the new Duquesne plant will reduce that cost by nearly one-half. English manufacturers have, however, perhaps less to fear from competition across the Atlantic, than from that of continental States, and from this point of view the details given of the production of the German and Luxemburg iron districts are of great interest. We do not find the same gigantic output as in America, but "in Germany there is a readiness to adopt new methods, and to take advantage of every point in the game of international competition, which cannot but go far to ensure success." A good example of this is given in the readiness with which German steel makers have adopted the basic process. This process had its origin in England, and though taken up by a few enterprising firms of steel makers, it may be said to have been received with but cold welcome by the trade in general. English makers preferred to import the hematite ores suitable for the acid process, neglecting our own vast resources of ore not suitable for acid steel. The Germans having somewhat similar iron ores, eagerly took up basic steel making, so as to utilise native deposits, and did not rest until they had overcome those defects and difficulties in manufacture, which always attend a new process, and which were, perhaps, exceptionally formidable in this case. They have received their reward, for at the present time an enormous trade is done in Germany in basic steel which can be produced at a cheap rate, whilst the quality is sufficiently good for ordinary engineering purposes. In Belgium, too, we see the result of an intelligent appreciation of modern improvements—both by masters and men—combined with a perseverance and industry which enables advantage to be taken of the smaller details that, in the bulk, go to make success. One thing the English manufacturer has against him is railway rates, and this is very strikingly brought out in a comparison made between the facilities which English manufacturers possess, as against those of the Belgium and German producer. As regards labour cost, Mr. Richards tells us there is not much to our disadvantage, but he says that our labour has become "far more difficult to manage, is much more ready to stop work in order to obtain an increase of wages, and is constantly agitating for fewer hours of work. Every concession made renders it more and more difficult to compete with the continent in the markets of the world, but our workmen cannot yet be brought to see this, neither can they be persuaded to cease opposition to machinery devices for saving labour and reducing cost; indeed all such appliances are jealously watched, and, if possible, their success is prevented." There is much truth in these remarks of

Mr. Richards, and the only cure for the evils he enumerates is to improve the intelligence and the status of the working classes. It is with regret that Englishmen too often see continental employers superior to those of this country in regard to the thoughtful care bestowed upon their workpeople. In some cases it is true, care of the workman is forced upon the manufacturer by legislation, but in a great many instances the continental iron and steel maker has recognised the wisdom of treating his workpeople liberally. Doubtless in England we may find many large-minded employers who, either from self-interest or from motives of a higher character, pay much attention to the well-being of their workmen, but too often the "hands" are looked on as simply an extension of the plant, their sole function being to give the maximum of labour on the minimum of outlay. It is hardly to be wondered at, under these circumstances, that self-seeking persons obtain the ear of the working man in this country, and so often advise them to their own detriment and that of the nation at large.

Mr. Windsor Richards concluded his address with some remarks on technical education. Referring to the want of intelligence on the part of operatives he said, "yet the favourite remedy of this state of things is, in many minds, to spread technical education all over the country; whereas if the results they desired unhappily be attained, the last state of the trade would be worse than the first, for we should have no hewers of coal, nor makers of steel." "Technical education" is so uncertain a quantity that it is not easy to arrive at what Mr. Windsor Richards exactly meant by his expression. We think, however, that his words are likely to be misleading if not mischievous. The most hopeful solution of the labour problem, in fact the only solution, is higher intelligence on the part of the workman, and there is no better way of fostering this intelligence than by giving operatives such knowledge as will enable them to appreciate the processes in which they are engaged. Experience proves that a man does not become less efficient as a labourer, even as a hewer of coal and a maker of steel, because he is educated, although frequently he may, by virtue of his education, rise above these positions. We must, however, leave Mr. Richards' address, and turn to the other parts of the proceedings.

At the last meeting of this Institution, a paper by Mr. W. H. Patchell, on "Steam Superheating" was read, the discussion on which was adjourned until the present meeting. Mr. Patchell's paper referred to various designs of superheater, the principal one treated upon being that of McPhail and Simpson. In this apparatus steam is taken from the boiler and passed to a superheater which utilises the waste gases from the furnace. In this way the steam acquires a certain amount of superheat. It is then taken back to the boiler, and circulates in the water space of the latter by means of an internal pipe. After this it passes to the engine. The object of the invention is to obtain thoroughly dry steam without the risk of it being highly superheated, and thus cutting cylinder faces, or leading to defects which have been experienced in time past in using steam above the temperature normal to the pressure. It will be seen, of course, that this superheater, so called, is not necessarily a superheater at all; it may be, or may not be, the result depending on the quantity of heat imparted to the steam by the waste gases, and to the length of time the steam is subjected to the influence of the water in the boiler by means of the internal pipe. Supposing the steam be superheated several degrees and then returned to the boiler, it will be subjected to the influence of water at a lesser temperature than itself, for the water in the boiler is practically at the temperature of saturated steam due to the boiler pressure. The superheated steam may be reduced to that temperature, but will not fall below it. Practically, we believe, in an installation with a McPhail superheater, as usually designed, the steam finally emerges from the internal pipe at a temperature above that due to its pressure, but generally to a small extent. It will, of course, be dry steam on finally emerging from the internal pipe; though possibly, in some cases, surface radiation in the steam pipe between the boiler and the engine may deprive the steam of its superheat. It is further to be noted that the heat which the superheated steam parts with, to the water in the boiler, is not lost, but goes to aid evaporation. If the degree of superheat of the steam as t passes into the engine cylinder be small, some of the steam will be almost immediately liquefied by the usual process of extraction of heat incidental to the working of any steam engine. If the heat used for superheating be wholly waste heat, there will of course be a gain due to the adoption of the apparatus; but against this must be put the first cost of the superheater. In any case it is an advantage to get dry steam, and the McPhail device must be credited with this.

The principal contribution to the discussion was made by Prof. W. C. Unwin, who claimed that Hirn should be credited with the practical introduction of the use of superheated steam. In Alsace he said superheaters are generally in use, and are found to be of great practical value. If the apparatus were intelligently designed, it was possible to use superheated steam without any of the dangers and troubles of which so much had been heard. A few years ago superheaters were largely fitted to a large number of steamships in the form of the well-known steam chimney, as doubtless the majority of our readers are aware. The advent of higher pressures, and consequent higher temperatures, however, brought difficulties. When steam of 30 to 60 lb. pressure was used, it was possible to increase the temperature of steam above that normal to the pressure, without introducing much complication, but when temperatures rose much above those mentioned, as they speedily did with the advance in boiler practice, superheating became a more serious matter. Improvements in the packing of glands, and the introduction of mineral lubricants, now enabled still higher temperatures of steam to be used without danger. It may be as Prof. Unwin says, that we can take useful example from the Alsatian practice, and thus another era of superheating has arisen. The introduction of the water tube-boiler also may supply an incentive to marine engineers in this direction. The limited water and steam space with this type of generator make it often difficult to get dry steam, so that a superheater would fill a useful place. Another point to be observed is, that if superheating of steam be used, steam jacketing is not necessary, or at any rate not so necessary as when non-superheated steam, often containing a considerable quantity of water, is passed to the engine. Perhaps when the paper on steam jackets by Messrs. Hudson and Donkin is read, we may get further light on this subject, and it is to be hoped ample time will be given for its discussion.

Mr. MacCarthy's paper on "Electric Welding of Steam Pipes" was a valuable and interesting contribution. Higher steam pressures have brought trouble to the marine coppersmith. The old brazed copper pipes have been found, by sad experience, to be dangerous fittings, several lives having been lost by their failure. Steel pipes have been accordingly substituted where high pressures are used; and so far as the pipes themselves are concerned, there is not much difficulty in producing a trustworthy article. The longitudinal welds of a lap-welded pipe are made either by rolls or by the gas-welding system with a hammer, in a thoroughly satisfactory manner, and experience has shown how flanged junctions can be made. It is where joints, such as elbows, T-pieces, &c., are required that the difficulty arises, and it is here that electric welding has come to the help of the marine engineer. On the table of the theatre Mr. MacCarthy exhibited several very fine specimens of steam fittings of the kind referred to, a four-way branch being a notable example. These were all made by the Benardos system of arc welding. Flanges are also welded to the length of pipe in the same manner; the method of working was described by the author as follows:—

"Ordinary low-tension continuous-current lighting dynamos are used; to the terminals of these a battery of Benardos accumulators is connected, into which the current flows continuously. When the welding circuit is closed, the current flows from the dynamos and accumulators; and large resistances are used when necessary. In this way a large discharge is obtained, equal to about twice the capacity of the dynamos, and the load factor of the apparatus is high. For some purposes it is possible to work without accumulators; but when this is done, the efficiency of the apparatus is not so high, because during part of the working period no current whatever is passing, and the machinery is running light."

For attaching the flanges to the pipes, the following method is adopted:—

"The flange is stamped out under the steam hammer in such a way that a V-shaped groove is left on the inside edge, extending about three-fourths through the thickness of the metal. The flange is next shrunk upon the tube, with its flat face outwards or at the end of the tube, and is carefully set in the exact position required. The welding consists in laying small pieces of steel in the V-shaped grove, and welding them in one by one by means of the electric arc, the welds being freely hammered between

each heat. The welder makes a complete circuit of the back of the flange, and fills it up sufficiently to make a fillet of about 1½ inches radius. In this way the flange is solidly welded to the tube at the back, and about three-fourths of the way through its thickness; but the front or outer side is not yet welded. The tube is then up-ended, and the outer side of the flange is welded to the tube, the only difference being that the heat of the arc is used to burn out a cavity all round the junction of the pipe and the flange, until the depth is reached at which the two have already been united; this cavity is then welded up in the same way as the back of the flange, thus ensuring that the flange is welded solid to the pipe right through."

One point in connection with electric work, to which the author called special attention, was the length and size of the arc which is used in the welding of various kinds of work. With a short arc, the carbon point is brought down too close to the steel, and the result is inferior work, not only from the presence of the carbon, but also because the heat is concentrated upon so small a surface that the strains set up in cooling are considerable. The longer the arc, the softer and more defined is the heat; and any slight strain which may be set up can be got rid of by careful annealing. A long arc is therefore indispensable to the proper working of the system.

The reading of this paper was followed by an animated discussion in which trade interests were not altogether neglected. One manufacturer from Sheffield expressed a preference for flanges forged solid from the end of the pipe, rather than for those electrically welded on in the manner described. No doubt the electrical welding gives a very trustworthy attachment between the flange and pipe—experience has proved this; and, equally without doubt, the solid forged flange is an excellent device. The merits of the two systems are reduced to commercial considerations. The same speaker, whilst bearing testimony to the very fine junctions, bends and T-pieces shown by the author, said that recourse to electrical methods for producing these was not necessary, as they could be made equally well, and at a cheaper rate, in the shape of crucible steel castings. That, however, is also a commercial point upon which we need not enter. The question as to whether electrical welding is really welding or fusing, was also discussed by several speakers at the meeting. The problem appears very much to be one simply of names. No doubt electrical welding, as described by the author, is not welding in accordance with the forgeman's old vocabulary; but whether it be welding or fusing, so long as it gives a good and trustworthy junction of the two metals, is a matter of small importance. There is no doubt that electrical fusing, if engineering purists insist on the term, enables work to be done which could not be attempted in any other way, and it will surely take its place in times to come as an engineer's workshop process. The methods of making the longitudinal seams in steam pipes by welding were described by the author in his paper. These methods are well known now, and have been in use for some years, so we need not refer to this part of the paper, further than to state that it gave rise to a discussion on the respective merits of solid drawn tubes made from the ingot (which of course have no longitudinal weld) and lap-welded tubes. On this point Mr. Mark Robinson gave some instructive data. He had made tests with lap-welded steel tubes and solid drawn steel tubes. We will not quote the details, as they were rather voluminous, but we will simply say that the lap-welded tube showed considerable superiority. It may be stated, however, that at the present time seamless steel tubes are being made by one firm in 12 ft. lengths, the diameter being 1 ft.; this is rather a remarkable development of the industry.

The meeting was brought to a close by the discussion on this paper.

The Summer Meeting of the Institution will be held this year in Belfast, and will commence on Tuesday, July 28.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Prof. Sir G. G. Stokes, Prof. A. R. Forsyth, and Prof. J. J. Thomson are to represent the University at the celebration in Glasgow of Lord Kelvin's jubilee next month. Prof. Thomson will also represent the University at the Sesquicentennial celebration of the founding of the College of New Jersey and the inauguration of Princeton University, to be held next October.

In view of the extreme financial depression which has befallen the Colleges, the Chancellor has diminished by £3000 a year the contribution payable by them to the University in 1896–98.

The Council of the Senate has reported in favour of the affiliation of the University of Toronto and the University of Bombay.

Prof. T. W. Bridge and Mr. Charles Davison have been admitted to the degree of Doctor of Science.

OWING to the efforts of the Chairman of the District Council, it will not be long before the town of Bilston is provided with an efficient technical and art school. No less than £2400 has been locally subscribed, and it is confidently expected to bring the amount up to £2500 at least, when it will be possible to claim £1000 from the Science and Art Department, and £500 from the County Council, making a total of £4000. A Committee has been formed in connection with the workmen of the district for raising £250 towards the expenses of furnishing.

SCIENTIFIC study is given a little encouragement by the London Chamber of Commerce. Among the prizes offered for competition in the Chamber's seventh examination for junior commercial education certificates, to be held in the Hall of the Institute of Chartered Accountants, Moorgate-street, E.C., on July 6, are:—Prizes of £5 and £2 for proficiency in commercial history and geography; prize of £5 for proficiency in algebra, Euclid, mechanics, and hydrostatics; prizes of £3 and £2 for proficiency in chemistry; prizes of £3 and £2 for proficiency in electricity and magnetism; prizes of £3 and £2 for proficiency in sound, light and heat; and prizes of £3 and £2 for proficiency in natural history. There will also be awarded the "Princess Louise" prize of £35 for general proficiency, and the "Textile Section" prize of £36 15s. (conditions undetermined); while the Aberdeen Chamber of Commerce offer a prize of £2 2s. for proficiency in mathematics.

AT a meeting of the Technical Instruction Committee of the Cornwall County Council, held at Truro last week, the Agricultural Sub-Committee recommended "That in view of the Government proposals, affecting secondary education, as set out in the Education Bill now before the House, it is desirable to defer taking immediate steps to secure land and premises for the purpose of establishing a farm school in this county." The recommendation, which was proposed by the Chairman, was eventually adopted. During the discussion which took place upon the matter, it was made clear that the original intention had been to found a central institute because the only suitable efficient schools in the county were of a proprietary character, and from the provisions of the Technical Instruction Act, 1889, it was impossible to assist these. The object of deferring the question was to enable the Committee to see if, by the terms of the new Act, schools of only a semi-public character could be assisted, and also to first become acquainted with the powers of the new Educational Committee before they committed themselves to any policy.

A SHORT time ago attention was called in these columns to the low financial condition of the University College, Bristol. We now learn from the *Lancet* that the Council of the College issued last week an urgent appeal for pecuniary assistance to the inhabitants of Bristol and the West of England. The Council earnestly appeal for a capital sum of £10,000 to clear the college from debt, and for an addition to the annual sustentation fund of £700, which would restore the fund to the £1200 subscribed in 1882, not less than which is required to meet the annual expenditure and to secure the Government grant. The Council emphasise the need of a permanent endowment, and suggest that wealthy citizens of Bristol and the West should associate their names, as in other colleges, with the endowment of professorships. The donations already promised for the capital fund amount to £5334, and to the sustentation fund about £100. We note with pleasure that, at a recent meeting of the Technical Education Committee of the Bristol Corporation, it was decided to recommend the Council to make a grant of £2000 to the funds now being raised on behalf of the college, to be conditional upon the £10,000 being obtained, and on the acceptance of two representatives of the Town Council upon the Governing Body.

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. xviii. No. 2, April. —The intermediary orbit, *i.e.* the Moon's periodic orbit relatively to the Sun obtained from the variation terms when all terms but those depending on the ratio of the mean motions only are omitted, has been considered in vol. i. by Dr. Hill, and subsequently in the *Acta Mathematica* (vol. viii.) the same writer obtained an expression for the motion of the Moon's perigee, so far as it depends on the ratio of the mean motions. These papers have been followed by others by Prof. E. W. Brown, in which the terms depending on the solar parallax and the lunar eccentricity are computed.—The object of the opening paper of the present number, on the inclinational terms in the Moon's coordinates, by P. H. Cowell, is to take into account, according to Dr. Hill's method, the inclination of the orbit, considering it as being the manifestation of a small oscillation about Dr. Hill's distorted circular orbit, which relatively to the Sun is a closed curve. The terms multiplied by the first power of the inclination have been calculated to the sixth order, and an expression for the part of the motion of the Moon's node, that depends upon the mean motions only, has been found as far as the eighth order, *i.e.* one term further than in Delaunay's series. The terms multiplied by the square of the inclination have been calculated to the fifth order, and the terms multiplied by the third power of the inclination to the fourth order in m. The notation adopted is that of the paper by Prof. Brown (*Am. Journ. Math.*, vol. xvii.).—A short note by A. S. Chessin, on non-uniform convergence of infinite series, brings out more clearly a point in a previous note (vol. xviii. No. 1), which the writer says has been misunderstood.—On a certain class of equipotential surfaces, by B. O. Peirce, discusses the nature of such systems of plane curves as are at once the right sections of possible systems of equipotential cylindrical surfaces belonging to distributions of matter which attract, according to the law of nature, and the generating curves of possible systems of equipotential surfaces of revolution.—M. Petrovitch contributes "Remarques sur les équations de dynamique et sur le mouvement tautochrone."—A note on C. S. Peirce's paper on a quincuncial projection of the sphere, by J. Pierpont, corrects an inaccuracy in that paper (vol. ii. p. 394). Mr. Pierpont, in a note on the invariance of the factors of composition of a substitution-group, gives a much simplified proof of this important theorem.—H. Maschke, in a long article (pp. 156-188) on the representation of finite groups, especially of the rotation-groups of the regular bodies of three- and four-dimensional space, by Cayley's colour diagrams, shows that Cayley's method (the theory of groups, graphical representation, *Am. Journ.*, vol. i., and on the theory of groups, *Am. Journ.*, vol xi.) can be readily applied to the construction and investigation of numerous groups of higher orders. In particular, the writer says, the colour diagrams for the rotation groups of the regular bodies can be arranged in such a way that they lend themselves much easier, at least in some respects, to a study of the groups concerned, than even the models of the regular bodies. Numerous diagrams of interest accompany the paper.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, March 19.—Mr. A. G. V. Harcourt, President, in the chair.—The following papers were read:—The constitution of a new organic acid resulting from the oxidation of tartaric acid, by H. J. H. Fenton. The acid obtained by the oxidation of tartaric acid in presence of iron seems to be a dihydroxymaleic acid of the constitution C(OH)(COOH):C(OH)(COOH); an isomeric acid has also been prepared, which is possibly the corresponding dihydroxyfumaric acid.—The volume and optical relationships of the potassium, rubidium and cæsium salts of the monoclinic series, $R_2M(SO_4)_2$, $6H_2O$, by A. E. Tutton. A detailed investigation of the physical properties and volume relationships of the twenty-two salts of this series, of which the author has previously determined the morphological constants, leads to a number of important conclusions; the alkali metal R in salts of this series, exerts a predominating influence on the crystallographical characters of the substances.—Comparison of the results of the investigations of the simple and double sulphates containing potassium, rubidium and cæsium, by A. E. Tutton.—The bearing of the results of the investigations of the simple and double sulphates containing potassium, rubidium and cæsium, upon the nature of the structural unit, by A. E. Tutton. No considerable contraction occurs in the formation of the double salts of the series $K_2M(SO_4)_2$, $6H_2O$ from its constituent salts, so that it is improbable that these constituents are in chemical combination in the solid state; this conclusion is supported by the fact that these salts do not exist in solution, and that many of them are very unstable. It is not necessary to assume that the structural units of crystals consist of more than one chemical molecule in the case of double salts or salts containing water of crystallisation.—The hydriodides of hydroxylamine, by W. R. Dunstan and E. Goulding. The only crystalline hydroxylamine hydriodides which the authors have been able to prepare have the compositions $3NH_3O$, HI and $2NH_3O$,HI.—An analysis of water from the dropping well at Knaresborough in Yorkshire, by B. A. Burrell.—Contributions to the knowledge of ethylic acetoacetate. Part I. Acetonylmalic acid, by S. Ruhemann and E. A. Tyler. Ethylic sodioacetoacetate and ethylic chlorofumarate react with formation of ethylic methyldihydrofurfurantricarboxylate, which on hydrolysis with alcoholic potash yields acetonylmalic acid CMe(OH): CH.CH(COOH).CH(OH).COOH.—The action of lead thiocyanate on the chlorocarbonic esters. Part I. Carboxyethylthiocarbimide and its derivatives, by R. E. Doran.—An auxiliary assay balance, by R. Law. The author describes a balance for assay work, which gives the weight of the gold "cornet" with such accuracy that on its transference to the ordinary assay balance, the observer can put the requisite weight on the balance pan at once; the remaining fraction can then be determined by the rider alone.—Charas: the resin of Indian hemp, by T. B. Wood, W. T. N. Spivey, and T. H. Easterfield. Charas, the resin of *Cannabis indica*, contains a terpene, a sesquiterpene, a paraffin, $C_{29}H_{60}$, and a red oil, $C_{18}H_{24}O_2$; the latter, in doses of 0·05 gram, produces intoxication and sleep.—Note on the decomposition of α-chloronitrocamphor, by A. Lapworth.—On heating α-chloronitrocamphor, camphorquinone is produced.—π-Bromocamphor, by C. Revis and F. S. Kipping.—Oxidation products of α-bromocamphorsulphonic acid, by A. Lapworth and F. S. Kipping. On oxidising ammonium α-bromocamphorsulphonate with nitric acid, products are obtained which seem to be a sulpholactone, $C_{10}H_{12}SO_4Br_2$, a hydroxydibromocamphorsulphonic acid and an ammonium dihydrogen π-sulphocamphoric acid.—On the xylic and xylidinic acids, by W. H. Bentley and W. H. Perkin, junr.

March 26.—Anniversary Meeting.—Mr. A. G. V. Harcourt, President, in the chair.—After the reading of the presidential address and the transaction of the usual business, a ballot was taken for the election of officers and Council for the ensuing year.

Geological Society, April 15.—Dr. Henry Hicks, F.R.S., President, in the chair.—The President announced that a portrait in sepia of Prof. Bonney, executed by Mr. Trevor Haddon, had been presented to the Society by thirty-four subscribers, Fellows of the Society.—The following communications were read:—The Junction-Beds of the Upper Lias and Inferior Oolite in Northamptonshire. Part I. Physical and Chemical, by Beeby Thompson. The author, while combating the view that a considerable unconformity existed between the Upper Lias and the Inferior Oolite of Northamptonshire, brought together much evidence to illustrate the effects of slipping, and to show that these effects may be mistaken for those of unconformity. He also applied the evidence which he had collected to illustrate certain points in the physics of valley-formation. After giving details as to the horizon of the springs of the district, the distribution of water in the Inferior Oolite, and the development of the springs, he argued that every valley of the district has been elongated in the direction which it now has by a stream originating in a spring always at its head, and that the development of channels towards particular points of discharge had been the chief agent in initiating the formation and guiding the direction of all the minor valleys of the river-system within the influence of the same set of beds. A description of the characters of the slopes followed, and their significance was discussed. The structure of the hills and valleys of the district occupied the next portion of the paper, and the author considered that corresponding to the deepening of a valley by denudation there was uplifting of the beds below it, and at the same time an outward and upward thrust along the hillside which lifted beds there; also, that hills were reduced in height by sinking as well as by denudation of their

upper parts. In discussing the question of unconformity between the Inferior Oolite and Upper Lias, the rarity of exposures of true junctions was noted, the junctions which have been chiefly examined by other observers being obscured by slipping; and reasons were given for inferring an absence of unconformity at the horizon, both on account of the character of the true junctions, and from other considerations. The author, however, gave reasons for believing that a slight unconformity occurs in the Upper Lias, so that the lower part of the *jurensis*-zone is absent, and not its upper part, as has been elsewhere inferred.—Contributions to the stratigraphy and palæontology of the *Globigerina*-limestones of the Maltese Islands, by J. H. Cooke. A bibliography of the *Globigerina*-limestones, followed by some remarks on the physical features and general distribution of the strata.—On the geology of the neighbourhood of Carmarthen, by Miss Margaret C. Crosfield and Miss Ethel G. Skeat. The area described lies approximately within a four-mile radius of Carmarthen. The beds of the district have been subjected to complicated foldings, amongst which an earlier set, giving rise to a number of small anticlines with north-and-south axes, and a later more extensive set, due to the series of earth-movements which produced the great Condrusian ridge, producing anticlines and synclines having a general east-and-west trend, can be made out. The rocks forming the subject of the present paper occur in one limb of a complex anticline produced during the latter set of movements. In the discussion that followed, the President congratulated the authors on the important discoveries which they had made. The finding of Tremadoc rocks in the neighbourhood of Carmarthen was a fact of great importance, and might lead to the discovery of still older rocks in that area. The succession closely resembled that found in Pembrokeshire; but it was now carried further east than had previously been done, though the work of the late T. Roberts and Mr. Marr had led to the idea that rocks at least as old as those of Arenig age would be found in this area.

Linnean Society, April 16.—Mr. W. Percy Sladen, Vice-President, in the chair.—Mr. George Massee read a paper on the types of Fungi in the collection of the late Rev. M. J. Berkeley, which was presented to Kew in 1879, and which contains rather more than 11,000 species. Many of the species were described more than fifty years ago; hence the diagnoses are in some cases too brief, and do not embody points which at the present day are considered to be of importance. In many instances this has led to the same species being re-described by others as new. Mr. Massee now supplied careful descriptions of the types, with a view to obviate future confusion, and to secure for Berkeley as the original describer the priority in nomenclature which is justly his.—Mr. A. D. Michael read a paper upon the internal anatomy of *Bdella* (the Red-snouted Mite), giving the results of three years' work and of many hundreds of dissections and serial sections. The material was furnished chiefly from the Zoological Station at Port Erin, and the subject is practically new, only one paper (describing a few parts of the female) having been hitherto published.

Zoological Society, April 21.—Sir W. H. Flower, K.C.B., F.R.S., President, in the chair.—Mr. Sclater exhibited and made remarks on some specimens from Nyasaland, lately sent home by Sir H. H. Johnston, K.C.B. Amongst these was a fine head of the sable antelope (*Hippotragus niger*) from the Zomba plains, and an example of the brindled gnu (*Connochætes gorgon*), or of a nearly allied form, believed to be the first specimen of this antelope sent home from British East Africa.—Mr. Sclater also exhibited, by the kind permission of Mr. Justice Hopley, of Kimberley, a pair of horns of the so-called *Antilope triangularis*, said to have been obtained somewhere on the Zambesi. These horns were now generally supposed to be abnormal horns of the cow eland.—Mr. W. E. de Winton gave an account of a small collection of mammals from Ecuador, lately sent to the British Museum by Mr. L. Söderstrom, H.B.M. Consul at Quito. It contained examples of only three species, but two of these appeared to be new to science. One of them was a new deer, proposed to be called *Pudua mephistophelis*, and the other a rodent of the genus *Icthyomys*, which was named *I. söderstromi*.—Mr. F. E. Beddard, F.R.S., read a paper on the anatomy of a grebe (*Æchmophorus major*), and added some remarks upon the classification of the Charadriiform birds, to which he considered the auks to be more nearly related than to the grebes.—A communication was read from Messrs. F. D. Godman, F.R.S., and O. Salvin, F.R.S., on the butterflies of St. Vincent, Grenada, and the adjoining islands, based on the collections made by Mr. Herbert H. Smith.—A communication was read from Miss E. M. Sharpe containing an account of the Lepidoptera obtained by Dr. Donaldson Smith during his recent expedition to Lake Rudolf. Examples of ninety-one species were obtained, of which two were apparently new. These were described as *Panopea walensensis* and *Papilio donaldsoni*.—A second paper by Miss E. M. Sharpe contained an account of the Lepidoptera obtained by Mrs. E. Lort Phillips in Somaliland. Eighty-four species were enumerated, one of which, *Teracolus ludoviciæ*, appeared to be undescribed.—A communication from Mr. W. F. Kirby contained descriptions of some dragon-flies obtained by Mr. and Mrs. Lort Phillips in Somaliland. Three of these were described as new to science.

PARIS.

Academy of Sciences, April 27.—M. A. Cornu in the chair.—Observations of the Swift comet (April 13, 1896) made with the large equatorial of the observatory of Bordeaux, by MM. G. Rayel, L. Picart, and F. Courty.—Macular or perifoveal œdema of the retina, by M. J. P. Nuel.—New divisions in the rings of Saturn, by M. Flammarion (see p. 17).—Remarks on a communication of M. R. Liouville, entitled "On the rotation of solids," by M. N. Joukovsky. A claim for priority for some Russian mathematicians.—On the transition from the state of flow through an orifice to flow over a weir, by M. Hégly.—On a self-registering thermometer balance, containing either gas or saturated vapour, by MM. H. Parenty and R. Bricard. The two arms of a balance carry respectively a barometer and an air thermometer, both dipping into the same mercury trough. At constant temperature, and with varying atmospheric pressures, the alterations in the weights of the two arms caused by the movements of the mercury are identical, and the balance remains in equilibrium, but an alteration of temperature causes a motion of the beam, which can easily be made self-registering. For a small range of temperature the sensitiveness of the apparatus is considerably increased by substituting a volatile liquid for the gas. The device also readily acts as a temperature regulator.—Mode of action of the X-rays upon a photographic plate, by M. R. Colson. An account of some experiments made with a view to ascertain whether the X-rays impress the photographic plate directly, or whether they are transformed by the glass or film into secondary radiations of a phosphorescent nature, to which the photographic action may be ascribed. All the results pointed to the action being direct, no trace of action due to secondary rays being observable.—On the heterogeneity of the radiations emitted by Crookes' tubes and on their transformation by screens, by M. F. P. Le Roux. The name "hyperdiabatic radiations" is proposed as more suitable than X-rays.—Action of the X-rays upon electrified bodies, by MM. L. Benoist and D. Hurmuzescu. A study of the effect of the nature of the gaseous dielectric in which the electrified substances are placed upon the rate of discharge by the X-rays. The speed of dissipation in air was found to be approximately proportional to the square root of the pressure. At the same pressure the rate of loss of charge with air and carbon dioxide, and air and hydrogen was roughly inversely proportional to the square roots of their densities.—On electrified Röntgen rays, by M. A. Lafay.—Optical superposition of six asymmetric carbon atoms in one active molecule, by MM. P. A. Guye and C. Goudet. The rotations for four divaleryl tartrates of amyl are given, the number calculated from the assumption of the algebraic superposition of the optical effects of the several asymmetric carbon atoms approximates to one of these experimental values.—On a basic nitrate of magnesia, by M. G. Didier. By adding magnesia to a strong solution of magnesium nitrate, the nitrate $Mg(NO_3)_2.2MgO + 5H_2O$ is obtained.—On crystallised sesquiphosphide of iron, by M. A. Granger. Ferric chloride heated to redness in the vapour of phosphorus gives the phosphide Fe_2P_3, which is obtained in the crystalline form if the reaction is carried on slowly.—Study of peridinitronaphthalene, by M. C. Gassmann.—On the tartrate of phenylhydrazine and its derivatives, by M. H. Causse.—Heat of combustion of some cyanogen derivatives, by M. Guinchant. The introduction of the cyanogen group increases the molecular heat of combustion by ninety calories.—On the distillation of the first acids of the fatty series, by M. E. Sorel.—On zeolites and the substitution of the water they contain by other substances, by M. G. Friedel.—On the determination, by a new photometric method, of the laws of luminous sensibility to blacks and greys, by M. C. Henry.—Measurement of odours

in the air, by MM. A. Gerardin and M. Nicloux. The variation in volume of air after treatment with a glowing platinum wire is suggested as giving a measure of bad odours in air.—Statistical researches on the cultivated oyster on the coasts of France, by M. G. Roché.—On the metamorphic gypsums of Algeria, by M. L. Gentil.—The allotropic state of the elementary gases, by M. C. V. Zenzer.—A new general method for calculating the roots of algebraical equations which contain four terms and more, by M. Wisthaler.

DIARY OF SOCIETIES.

London.

THURSDAY, May 7.

Royal Society, at 4.30.—On the Liquation of certain Alloys of Gold: E. Matthey.—On the Occurrence of the Element Gallium in the Clay-Ironstone of the Cleveland District of Yorkshire. (Preliminary Notice): Prof. Hartley, F.R.S., and H. Ramage.—The Electromotive Properties of Malapterurus electricus: Prof. Gotch, F.R.S., and G. J. Burch.—The Occurrence of Nutritive Fat in the Human Placenta (Preliminary Communication): Dr. T. W. Eden.

Royal Institution, at 3.—The Art of Working Metals in Japan: W. Gowland.

Linnean Society, at 8.—On the Tooth-Genesis of the Canidæ: Dr. H. Marett Tims.—Exhibitions: Lantern-Slides illustrative of the Habits of the Tiger-Beetle, Cicindela campestris: F. Enock.—Preparations of the Hermaphrodite Glands of Apus: H. M. Bernard.

Chemical Society, at 8.—Ballot for Election of Fellows.—Morin, Part I.: Dr. H. Bablich and A. G. Perkin.—Luteolin, Part II.: A. G. Perkin.

Institution of Civil Engineers, at 8.—The "James Forrest" Lecture: Physical Experiment in relation to Engineering: Dr. Alexr. B. W. Kennedy, F.R.S.

Iron and Steel Institute (Institution of Civil Engineers), at 10.30 a.m.

Gresham College (Basinghall Street), at 6.—The Planet Saturn: Rev. E. Ledger.

FRIDAY, May 8.

Royal Institution, at 9.—Electric Shadows and Luminescence: Prof. Silvanus P. Thompson, F.R.S.

Royal Astronomical Society, at 8.—Note on a Determination of Precession and Drift, based on Auwer's Proper Motions: R. H. M. Bosanquet.—Royal Observatory, Greenwich: Diameters of Jupiter measured with the Filar and Double-Image Micrometers.——And *probably*: Photographs of the Spectra of the Helium Class of Stars: F. McClean.—Royal Observatory, Greenwich: Observations of Comets a 1896 (Perrine-Lamp) and of Comet b 1896 (Swift).

Physical Society, at 5.—On Dielectrics: R. Appleyard.—On the True Resistance of the Electric Arc: Messrs. Frith and Rodgers.

Iron and Steel Institute, at 10.30 a.m.—On the Rate of Diffusion of Carbon in Iron: Prof. W. C. Roberts-Austen, C.B., F.R.S.—On some Alloys with Iron Carbides: J. S. de Benneville.—On Mond Gas as applied to Steel-making: John H. Darby.—On Hot Blast Stoves: B. J. Hall.—On the Hardening of Steel: H. M. Howe.—On the Introduction of Standard Methods of Analysis: Baron Hanns Jüptner von Jonstorff.—On the Production of Metallic Bars of any Section by Extrusion: Perry F. Nursey.—On Mr. Howe's Researches on the Hardening of Steel: F. Osmond.—On the Treatment of Magnetic Iron Sand; E. Metcalf Smith.—On the Making of the Middle Lias Ironstone of the Midlands: E. A. Walford.

Affiliated Photographic Societies, at 8.—Process Work Applications: W. T. Wilkinson.

Gresham College (Basinghall Street), at 6.—The Planet Saturn: Rev. E. Ledger.

Malacological Society, at 8.

SATURDAY, May 9.

Royal Botanic Society, at 3.45.

Geologists' Association (Liverpool Street Station), at 2.3.—Excursion to Chingford Museum and Epping Forest. Director: T. V. Holmes.

MONDAY, May 11.

Society of Arts, at 8.—Applied Electro-chemistry: James Swinburne.

Royal Geographical Society, at 8.30.—Through the Central Sudan to Sokoto: William Wallace.—Hausaland: Rev. Chas. H. Robinson.

TUESDAY, May 12.

Royal Institution, at 3.—Ripples in Air and on Water: C. V. Boys, F.R.S.

Society of Arts, at 8.—The Future of the Fine Art of Wood Engraving: W. Biscombe Gardner.

Anthropological Institute, at 8.30.—Recent Observations on the Andamanese by Mr. M. V. Portman: Dr. J. G. Garson.—Photographic Apparatus for Travellers: Dr. J. G. Garson.—The Cranial Characteristics of the South Saxons compared with those of some of the other Races of Great Britain: R. J. Horton-Smith.—An Unpublished Batak Creation Legend: Heer C. M. Pleyte.

Institution of Civil Engineers, at 8.—Papers to be further discussed: American and English Methods of Manufacturing Steel Plates: Jeremiah Head.—Four American Rolling-Mills: Samuel T. Wellman.

Royal Photographic Society, at 8.—Dry Plates for Röntgen Ray Photography: H. Snowden Ward.—Notes on the Pyro-developed Image: Alfred Watkins.—A New Stripping Film for Negative Work: J. B. B. Wellington.

Royal Victoria Hall, at 8.30.—The New Photography: A. W. Porter.

WEDNESDAY, May 13.

Society of Arts, at 8.—Tunnelling by Compressed Air: E. W. Moir.

Geological Society, at 8.—An Account of a Head or Gateway driven into the Eastern Boundary-Fault of the South Staffordshire Coalfield: William Farnworth.—Dundry Hill: its Upper Portion, or the Beds marked as Inferior Oolite (G 5) in the Maps of the Geological Survey: S. S. Buckman and E. Wilson.—On the Geographical Evolution of Jamaica: Dr. J. W. Spencer.

THURSDAY, May 14.

Royal Institution, at 3.—The Art of Working Metals in Japan: W. Gowland.

Society of Arts, at 4.30.—Tea Planting in Darjeeling: G. W. Christison.

Mathematical Society, at 8.—On the Application of the Principal Function to the Solution of Delaunay's Canonical System of Equations: Prof. E. W. Brown.

Institution of Electrical Engineers, at 8.—The Influence of the Shape of the Applied Potential Difference Wave on the Iron Losses in Transformers: Stanley Beeton, C. Perry Taylor, and J. M. Barr.

FRIDAY, May 15.

Royal Institution, at 9.—Cable-laying on the Amazon River: Alexander Siemens.

Epidemiological Society, at 8.

Quekett Microscopical Club, at 8.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Biological Experimentation: Sir B. W. Richardson (Bell).—Elementary Practical Physics: W. Watson (Longmans).—Quain's Elements of Anatomy, Appendix, 10th edition (Longmans).—The Student's Lyell: edited by Prof. Judd (Murray).—Riverside Letters; G. D. Leslie (Macmillan).—A History of the Warfare of Science with Theology in Christendom: Dr. A. D. White, 2 Vols. (Macmillan).

Pamphlets.—Slavery and Servitude in the Colony of North Carolina: Dr. J. S. Bassett (Baltimore).—The Crambidæ of North America: Dr. C. H. Fernald (Massachusetts).—Report of the Marlborough College Natural History Society, 1895 (Marlborough).

Serials.—Memorie della Societa Geografica Italiana, Vol. v. Part 2 (Roma).—Humanitarian, May (Hutchinson).—Bulletin de la Société Impériale des Naturalistes de Moscou 1895. No. 4 (Moscou).—Fortnightly Review, May (Chapman).—History of Mankind: F. Ratzel, translated, Part 8 (Macmillan).—National Review, May (Arnold).—Himmel und Erde, April (Berlin).—Journal of the Scottish Meteorological Society, third series, Nos. xi. and xii. (Blackwood).—Century Magazine, May (Macmillan).—Geographical Journal, May (Stanford).—Contemporary Review, May (Isbister).—Proceedings of the Physical Society, May (Taylor).—Scribner's Magazine, May (Low).—Zeitschrift für Physikalische Chemie, xix. Band, 4 Heft (Leipzig).—Archives of Clinical Skiagraphy: S. Rowland, Part 1 (Rebman).—Westminster Review, May (Warne).

CONTENTS.

THURSDAY, MAY 14, 1896.

FLIGHT.

The Aeronautical Annual, 1896. Edited by James Means. Medium 8vo, pp. 158. (Boston: W. B. Clarke and Co. London: Wm. Wesley and Sons, 1896.)

Zur Mechanik des Vogelfluges. Von Dr. Fr. Ahlborn. Demy 4to, pp. 134. (Hamburg: L. Friedrichsen and Co., 1896.)

TILL quite recently, artificial flight was regarded in much the same light as perpetual motion, the philosopher's stone, and other insoluble problems. But, now that Maxim, Langley, and others have demonstrated the possibility of overcoming the purely mechanical difficulties of flight, a wide field has been thrown open for scientific research in investigating the laws underlying the flight of birds and their practical application to the flight of man. The present record of investigations performed and theories propounded during the past year, will prove of great value to all who are interested in the subject by indicating what work has been done and what still remains undone.

The "Annual" opens with a long account by Lilienthal of recent experiments performed with his new apparatus, in which two superposed wing surfaces are employed instead of one. A description of these experiments was given in NATURE for January 30; but it may be interesting to call attention to the diagram of the undulating path of Lilienthal's machine when raised by a sudden head-wind and again allowed to descend. The motion bears a striking resemblance to that of a model glider allowed to descend in still air, although in the latter case the undulatory course is not due to any wind beyond what the glider makes for itself in its descent.

After a short editorial note on the analogy between the development of the flying machine and that of the modern bicycle, we have a well-written article by Maxim on "Natural and Artificial Flight." Our interest naturally centres round the sections dealing with the author's experiments on the relative advantages and disadvantages of narrow and wide planes. These experiments fully confirm the theory that narrow superposed planes possess greater lifting power per square foot than a single wide plane, a principle which Maxim proposes to utilise most ingeniously in his next machine by constructing his condenser of aeroplanes capable of lifting their own weight + 1000 lb. additional. Maxim, however, doubts whether in an actual machine it may be safe to dispense with wide planes altogether, on account of the risk arising in case of a sudden breakdown. Possibly a suitable compromise may result from adopting the "cellular" principle, which has been introduced with such success in the Hargrave kite. A number of important experiments with this and other kites, notably the "Malay" kite, are described in subsequent articles of the "Annual."

That aerial navigation is regarded as a subject of national importance on the other side of the Atlantic, is evidenced by the Bill introduced into the Senate of Washington on December 4, 1895, to provide for the award of money prizes of 100,000 dols. and 25,000 dols., the first for the successful achievement of mechanical flight, and the second for improvements in soaring machines. The editor of the "Annual" evidently inclines to the view that the final solution of the problem will result from a successful combination of the ingenuity of Lilienthal and Maxim.

Passing now to the flight of birds, we find in the first part of Dr. Ahlborn's memoir a detailed account of the form and structure of birds' wings, and their action in active or "rowing" flight. Marey's observations, in particular, are discussed at some length and freely criticised. The second part deals with the so-called soaring of birds—that is, their power of sustaining themselves continuously in the air without flapping their wings; the term "sailing flight," lately adopted by American writers as a literal translation of the French "vol à voile," is a better name for this action. Unfortunately Dr. Ahlborn's suggested explanation will not bear close examination from a theoretical standpoint. We may take it as an axiomatic consequence of general dynamical principles that when a current of air is blowing uniformly, the relative motion of a bird flying freely is the same as if the current were reduced to rest by applying an equal and opposite velocity both to the air and bird. Starting from this fact, Lord Rayleigh, Prof. Langley, and other investigators have long realised the impossibility of a bird supporting itself without the expenditure of muscular action in a *uniform* horizontal wind, and they have therefore had to seek other sources of energy, either in the variability of the wind velocity, or in local upward convection or other air currents, of which birds have been supposed to take advantage. Dr. Ahlborn, however, seems to hold the opinion that these variations are rather a hindrance than a help to the sailing bird, and that the kinetic energy of the wind is the sole source from which the bird derives its energy. To support this view, the author considers the action of a side wind on a bird sailing round and round in a circle, and he derives his supposed gain of energy by arguments which, though ingenious, are not at all convincing.

The theory of sailing flight is examined from a somewhat more plausible standpoint in the "Annual." Maxim inclines to the view that upward currents of air are the chief cause of the phenomena. Prof. Pickering contributes an article first published in 1889, in which he advocates the theory that the action depends on pulsations or gusts of wind, thus agreeing substantially with the views enunciated subsequently by Prof. Langley in his paper on "The Internal Work of the Wind."[1] Mr. Octave Chanute contributes the first portion of a paper on the subject, but as yet he deals exclusively with observations on sailing birds, and gives no theoretical explanation of their action. We regret that this writer has had to defer till next year's "Annual" his mathematical calculations connected with this singular phenomenon.

With such literature as the "Annual" at hand, the aeronaut should have little difficulty in deciding what experiments will be the most likely to lead to the realisation of artificial flight. G. H. B.

[1] Proceedings of the Aeronautical Congress at Chicago, 1893.

ASTRONOMY AND MILTON.

The Astronomy of Milton's "Paradise Lost." By Thomas N. Orchard, M.D. 8vo, pp. 388. (London: Longmans, Green, and Co., 1896.)

THIS work amounts in fact to a sketch of the history of astronomical discovery under the heads of the different departments of that science to which allusions are made in the great epic of the sublimest of our poets. The author justly remarks that the choicest passages in "Paradise Lost" are associated with these allusions; his main object has been their exposition and illustration, and his enthusiasm has led him to include a wealth of matter in carrying this out, which his readers will not regret. Milton lived in a critical period of astronomical progress. The discoveries of Galileo and Kepler had shown the great probability of the truth of the Copernican system; but Newton had not yet placed that system upon an irrefragable basis. Hence, "in describing the natural phenomena witnessed by our first parents, he adheres to the doctrine of the Ptolemaic system," whilst it is evident from many passages, particularly from the discourse between Adam and the angel in the eighth book, that he saw and appreciated the simplicity and beauty of the Copernican theory, on which he had doubtless conversed with Galileo, the "Tuscan artist," when on his travels in his younger days. All will remember how he represents Raphael as speaking with scarcely-veiled sarcasm of the sphere being supposed to be girded with "Centric and Eccentric scribbled o'er, Cycle and Epicycle, orb in orb," and Adam's difficulty at conceiving "how nature, wise and frugal, could commit such disproportions." Mr. Masson has, we need hardly say, written well on the cosmogony of "Paradise Lost" in the introduction to his edition of Milton; but Dr. Orchard has treated the subject with an abundance of illustration which fully justifies his hope that his contribution to Miltonic literature is both interesting and instructive. A chapter is devoted to the poet's visit to Galileo, and the allusions thereto; it is somewhat remarkable that Milton nowhere mentions the fact that the astronomer was then blind, an affliction which afterwards befell himself. Satan's shield is compared to the glass with which the moon was viewed from the top of Fesolé, a suburb of Florence, or in Valdarno, meaning the valley of the Arno in which that city was situated. Less pertinent to his subject is the sketch of the discoveries of Herschel and others in the sidereal heavens or the region of the fixed stars, of which scarcely anything was known until long after the time of Milton, the date of W. Herschel's birth being exactly a century after the poet's visit to Florence. Dr. Orchard does not seem to have disabused himself of the so-called island theory of the nebulæ, which, it is now clear, have some relation to our own galactic system; but, on the whole, his survey of the history of sidereal astronomy is accurate. There are many allusions in "Paradise Lost" to the starry host "spangling the hemisphere"; and one fine passage speaks of their motions "regular then most when most irregular they seem," which, however, may refer chiefly to the planets, and only by analogy to other systems conceived as probably existing, but not then known. Three constellations (besides the cluster of the Pleiades) are mentioned by name: Taurus, Ophiuchus, and Andromeda, the "fleecy star" near the last being generally supposed to be Aries or its principal star, though this is not certain. Much more frequent allusion is made in the poem to the sun than to any of the other orbs of the firmament, and that body is described "in a manner worthy of his unrivalled splendour and of his supreme importance in the system which he upholds and governs." Probably few passages in any poem are more familiar to all than Satan's address to the great luminary, whose beams the spirit of evil is appropriately represented as hating. Venus is alluded to under the name Hesperus, and as the evening star; and the Galaxy or Milky Way is described as "a broad and ample road, whose dust is gold and pavement stars." As to comets, they are twice introduced, oddly enough in one place as a simile to Satan, and in another to "the brandished sword of God." In the former of these places Milton makes a remarkable mistake by speaking of a comet "that fires the length of Ophiuchus huge in th' arctic sky." No part of Ophiuchus is thus situated; does he mean Draco? Dr. Orchard himself makes a mistake in p. 297, calling 1456 "the year in which the Turks obtained possession of Constantinople." The last chapter, on Milton's imaginative and descriptive astronomy, is, as might be expected, more full of passages from the great poem than any other, and appropriately closes a work which deserves, and will probably attain, a wide circulation.

W. T. LYNN.

OUR BOOK SHELF.

Cholera in Indian Cantonments, and how to deal with it. By E. H. Hankin, M.A. Pp. iv + 103. (Allahabad: *Pioneer* Press. Cambridge: Deighton, Bell, and Co., 1895.)

THE knowledge of the cholera microbe, gained during the past few years, is applied in this little volume in formulating directions for the prevention of the disease. The author has had exceptional opportunities of studying cholera outbreaks in India; and his experience in investigating sources of infection, renders the practical precautions he describes as necessary to prevent the spread of the disease in Cantonments, of great value to Cantonment magistrates, medical officers, and others interested in the question. Before dealing with the practical hints for the prevention of cholera, Mr. Hankin gives a brief account of the properties of the cholera microbe, which may be summarised as follows: (1) The cholera microbe when outside the human body, so far as is known, only lives and reproduces in water; (2) it is so small that it cannot be removed by filtration through ordinary domestic filters; (3) it is easily and rapidly destroyed by boiling; (4) it is rapidly destroyed by drying; (5) it is readily killed by acids; (6) it varies in virulence; (7) laboratory experiments show that its growth is favoured by the presence of traces of common salt and of nitrates in its culture fluids.

In a chapter on cholera epidemics, irregular and otherwise, it is shown that infection is caused by swallowing the microbe either in food or water; hence the precautions laid down are mainly concerned with the means for preventing the access of the microbe to the food and water supply, and with easy methods of disinfection. The instructions given are such as can readily be carried out, and though they are not so elaborate as the regula-

tions published by the German Government in the year 1893, an abridged translation of which forms an appendix to Mr. Hankin's book, they are sufficient for the purpose, and are better adapted to Indian Cantonments.

Chemical Experiments, General and Analytical. By R. P. Williams. Pp. 110. (Boston, U.S.A., and London: Ginn and Co., 1895.)

This is a practical, and, in some respects, an admirable, manual for chemical laboratories. The experiments described in the first half of the book instruct in metric measurements, glass manipulation, physical changes, chemical changes, and the preparation, properties and tests for the non-metallic elements and of the most important gaseous compounds. This part of the volume furnishes a good introductory course of practical chemistry. In the second part, the general and analytical reactions for metals are tabulated, the method adopted being to take each metal of a group separately and give the analytical reactions for it, and afterwards to treat the group in the same way. As a whole, the book should prove of service to students of analytical chemistry. Two features possessed by it offend the eye: one is the reformed chemical orthography, such as sulfuric for sulphuric, oxids for oxides, iodin for iodine, and so on; the other is the use of nearly sixty abbreviations, as, for instance, in the following sentences.

"Put into a t.t. or e.d. a thin piece of Cu, say $1^{qcm.}$ add 10 or 20 drops HNO_3" (p. 19).

"Put into a gen. (rec. or t.t.) 5^{g} FeS, $10^{c.c.}$ H_2O, and $5^{c.c.}$ HCl (or H_2SO_4)" (p. 42).

"Arrange the app. with inverted recs. as for the hydrogen exp." (p. 35).

Something may perhaps be said for the free use of abbreviations of this character by trained chemists, but their introduction in a book for young students is apt to lead to slovenly habits.

Traité de mécanique générale. Par H. Resal. Deuxième édition, entièrement refondue. Tome premier et deuxième. Pp. 166 and 300. (Paris: Gauthier-Villars, 1895.)

In editing the first two volumes of the seven volumes which form M. Resal's "Traité de mécanique," the author has seized the opportunity of completing certain subjects in the seventh volume, to which he directs attention in his preface. The scope of this treatise is so very great, covering all the ground of modern Theoretical and Applied Mechanics, that the author is debarred from entering into much detail. Thus, for instance, such a large subject as Hydrodynamics, including Hydraulics and Sound, is polished off in about sixty pages.

The work is obviously intended to serve as a text-book n Government technical schools, in which the amount of various knowledge required from a student is so great that he does not allow himself to become interested in details. G.

Modern Stone-Cutting and Masonry. By John S. Siebert, C.E., and F. C. Biggin, B.S. Pp. v + 47. (New York: John Wiley and Sons. London: Chapman and Hall, Limited, 1896.)

The arts of stone-cutting and masonry, and their applications in engineering and architectural practice in the United States, are briefly treated in this book, with special reference to the making of working drawings. The information given is of a thoroughly practical nature, and the fourteen plates, containing drawings of various forms of buttresses and arches, furnish useful examples of actual masonry work. The book will be found serviceable and instructive to students of the section of engineering and architecture described in it.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Two Brilliant Meteors.

On April 8 and 12, fine meteors were observed at various places in England.

The first of these appeared at about 8h. 21m. (April 8), and descriptions of its apparent path have reached me from Croydon, Kenley and Sutton in Surrey, also from Bridgwater, Reading and Crowthorne.

At Croydon the meteor was described by Mr. Salmon as a beautiful one, passing from Arcturus to near α Cassiopeiæ. Duration, ten seconds. The nucleus divided into two fragments. At Kenley Mr. Evershed noticed the meteor travelling from Arcturus to β Cassiopeiæ. It finally broke into fragments after a duration of five or six seconds. At first it was not brighter than a second magnitude star, but increased rapidly, so that at the end of its flight it was many times brighter than Venus. Mr. Bawtree, of Sutton, describes the path as from near β Draconis to β Cassiopeiæ, and estimated the duration as six to ten seconds. Mr. Corder, at Bridgwater, saw the meteor through trees, and at a low altitude, so that it did not appear to him brighter than Vega. Towards the end the nucleus divided into three. Its path was from $225^\circ + 15^\circ$ to $260^\circ + 40^\circ$, and duration six seconds. Mr. Saunder, at Crowthorne, Berks, says the meteor was several times as bright as Jupiter, and that before its disappearance the head was in several distinct pieces. Its path was from δ Boötis to near β Cephei. Mr. Davis, at Reading, describes the meteor as being equal to Venus, and passing in twelve seconds from near Arcturus to the point $340^\circ + 57^\circ$. It broke up into fragments at the end.

The second meteor appeared on April 12 at 8h. 6m., and I have accounts of it from Greenwich, Wellingborough, Bridgwater, Stokesay, Nottingham, West Malvern, Southport, Slough, Dunstable, Lochwinnoch, Renfrewshire, and several other places. At Greenwich, Mr. Dyson estimated the meteor as four times as bright as Jupiter, and describes the end part of its flight as being about 15° below the pole from W. to E. Mr. Tatman, of Wellingborough, says the meteor passed from N.E. to S.E., and occupied 12 seconds in its transit, ultimately disappearing behind a dark cloud. At Bridgwater the meteor moved from about 30° altitude in N. to 15° in N.E., and appeared to be about the size of the moon in one of her quarters. Mr. C. E. Clough, at Southport, says the meteor fell vertically about 15° to the right of Arcturus. In brightness it was estimated to equal two full moons. When first seen it was about 60° high, and it disappeared at an altitude of about 10° or 15°. At Nottingham, Mr. J. T. Wood says the meteor crossed the zenith, and was last seen near δ Virginis. It was ten times as bright as Jupiter. At Oxford, Mr. Robinson gives the time as 8h. 6m., and describes its course as from $7\frac{1}{2}^\circ + 60^\circ$ to $257\frac{1}{2}^\circ + 37^\circ$. Its duration was six seconds, and the meteor equalled and probably excelled Jupiter in brilliancy. At Lochwinnoch, Renfrewshire, Mr. P. Dewar noticed the meteor at 8h. 4½m., and says its motion appeared slow, lasting for four or five seconds. Its direction was from S.E. to E., and it disappeared near the horizon. At Coalbrookdale, Shropshire, the object was seen to come from the west, travel to N.E. and be lost towards E. The observations at Stokesay and West Malvern appear in NATURE of April 23, p. 581. I have a few other descriptions, and they are in satisfactory agreement.

The real paths of the two meteors appear to have been as follows:—

	April 8, 8h. 21m.	April 12, 8h. 6m.
Height at appearance	65 miles	118 miles
Position over	Straits of Dover	Formby, Lancashire
Height at disappearance ...	38 miles	34 miles
Position over	S. border Leicestershire	Doddington, Camb.
Length of observed path ..	161 miles	177 miles
Velocity per second	20 miles	19 miles
Earth point	Irish Sea	Woodbridge, Suffolk.
Radiant point	$204^\circ - 9^\circ$	$50 + 42$
Inclination of meteor's descent	9°	31

The meteor of April 8 was directed from a radiant in the eastern limits of Virgo, and not far from Spica. A fireball was seen on March 16 last, which was probably from the same radiant, as the paths converge on the point $205^\circ - 18^\circ$. This region is the centre from which many fireballs and ordinary shooting stars are directed in April and other months, as the following table will prove:—

Radiant point	Date.	Description	Observer or authority
210 − 6	January 5-11, 1870	Meteor shower	Tupman
205 − 8	January 20-22, 1877	,, ,,	Denning
200 − 5	January 20—Feb. 3, 1896	,, ,,	Herschel
204 − 10	January 21—Feb. 23, 1869	,, ,,	Denning from Tupman's obs.
202 − 9	February 13, 1869	,, ,,	Tupman
210 − 13	February 15-21, 1877	,, ,,	Denning
200 − 10	March 2-3, 1870	,, ,,	Tupman
205 − 18	March 16, 1896	Fireball	Denning
204 − 10	March 23, 1895	Meteor shower	Denning
204 − 8	March 31—April 12, 1872	,, ,,	Denning from Italian obs.
210 − 10	April 7-16, 1877	,, ,,	Denning
216 − 10	April 11, 1871	Fireball	Niessl
206 − 8	April 12-26, 1879	Meteor shower	Sawyer
210 − 7	April 1877	,, ,,	Corder
209 − 3	April 1874	,, ,,	Denning
209 − 9	April 1896	,, ,,	Herschel
198 − 8	April 18, 1841	,, ,,	Forshey
214 − 13	April 21, 1887	Fireball	Niessl
218 − 5	April 21, 1889	Bright meteor	Denning
210 − 9	April 19-23	Radiant 10 fireballs	,,
207 − 7	April 22, 1876	Meteor shower	,,
206 − 9	April 27, 1851	Fireball	Niessl
209 − 8	May 3-15, 1872	Meteor shower	Denning from Italian obs.
214 − 7	May 12, 1878	Fireball	Herschel
214 − 7	May 29, 1889	,,	Denning
217 − 6	July 7, 1895	,,	,,

The mean of the twenty-six positions is $209^\circ - 9^\circ$.

The fireball of April 12, 1896, came from a radiant in the N.W. sky at $50^\circ + 42^\circ$. The large meteor of April 22, 1894, had a similar radiant (*Observatory*, June, 1894), and the same may be said of the fireball of March 9, 1875.

Bristol, April 27. W. F. DENNING.

Becquerel and Lippmann's Colour Photographs.

I WISH to raise a point in connection with the optics of photochromy, which was not touched upon at the recent discussion at the Royal Society. The photochromatic spectra produced by the earlier workers, and especially by E. Becquerel about 1850, have long been known and have always appeared to be very mysterious to those who have repeated the experiments. When Prof. Lippmann's success with the interferential method was made known some five or six years ago, and his first results exhibited in this country, many of those who were acquainted with the previous methods of producing coloured spectra by direct impression came to the conclusion that all the earlier workers had unconsciously been producing the Lippmann effect. This supposition was not unreasonable. In Becquerel's method, for instance, which gave the most brilliant effects, the sensitive film of violet chloride is produced on a surface of metallic silver, and is thus backed by the necessary reflecting surface. Even when the colour sensitive chloride is on paper, as in the still earlier experiments of Robert Hunt and Sir John Herschel, it is not unreasonable to suppose that the bounding surface of the paper and silver haloid reflects sufficiently well to produce the necessary interference. At the discussion following Prof. Lippmann's paper, Lord Rayleigh raised the question whether the earlier and later results were not due to the same cause, but there seemed to be an impression that the Becquerel and Lippmann effects were produced by different causes. For my own part, I am bound to confess that the reasons assigned for arriving at this decision still appear to be inconclusive. The main points which have been allowed to prevail are that the Becquerel photographs cannot be fixed, that they appear of the same colour at whatever angle they are viewed, and that they appear of the same colour by transmitted and by reflected light. The fact that these photographs cannot be fixed is easily explained if we bear in mind that the silver salt, is not embedded in a vehicle, as in Lippmann's process, and that there is consequently nothing to hold the laminæ apart at the correct intervals when the fixing solution has done its work. The other points are less easy to explain; but it may be suggested that the difference is here due to the earlier experimenters having used coarse-grained films, in which the silver haloid particles are sufficiently large to *scatter* the colours produced in the film by the laminated structure of the alternating planes of decomposition and no decomposition. The question is a purely physical one, and may be put into the following form:—If the Lippmann effect is produced in a coarse-grained instead of in a transparent film, would not the Becquerel results be obtained? If physicists can answer this in the affirmative, the difficulty of supposing that similar results can be obtained by totally different causes would disappear.

R. MELDOLA.

Aquatic Hymenoptera.

UNDER the title "On Two Aquatic Hymenoptera, one of which uses its Wings in Swimming," Sir John Lubbock, Bart., read a paper before the Linnean Society, May 7, 1863, therein describing two most extraordinary insects, which he named *Polynema natans* and *Prestwichia aquatica*.

Last year I had the good fortune to obtain a large number of both sexes of the first named, which, after most critical microscopic examination, I identified as belonging to Haliday's *Caraphractus cinctus*, the unique characteristic of the "*keeled* metathorax" placing the matter beyond a doubt. The late Prof. Riley, to whom I had the pleasure of showing specimens, fully confirmed my opinion, as also did Mr. Charles Waterhouse.

The life-history of any of these minute Hymenoptera is not worked out in one season—very far from it; and since last year I have steadily followed up the chain of facts, my efforts being again rewarded by finding this most exquisite Hymenopteron this season within twenty miles of London.

Encouraged by my success, I continued my search for some hours at a small pond, and at last captured two female specimens of the long-lost-sight-of *Prestwichia aquatica* (Lubbock), which has not been recorded since its first capture by Sir John Lubbock in 1862—thirty-four years ago!

The two specimens (and *I*) have scarcely taken any rest since their capture yesterday morning, May 4; but they have been constantly running or paddling *under* water, never once having been to the surface. When I first put them into the tank, they had the *greatest* difficulty in forcing their way through the film; but as soon as that was accomplished, they moved about with their legs, as propellers, far more rapidly than did *Caraphractus cinctus* with its wings.

I am looking forward to capturing the *male Prestwichia aquatica*, which has not yet been recorded by any entomologist.

21 Manor Gardens, Holloway, N. FRED. ENOCK.

Dalton's Atomic Theory.

IN the review of "A New View of the Origin of Dalton's Atomic Theory," published in your issue of April 16, your reviewer, in summing up the evidence as to the origin of the atomic theory, makes an omission of such importance that it cannot be allowed to pass unchallenged. He attaches great weight to Thomson's statement that in 1804 Dalton himself informed him "that the atomic theory first occurred to him during his investigations of olefiant gas and carburetted hydrogen gas." Now these researches, as pointed out by your reviewer, were begun in the summer of 1804, a date which is assigned to them by Dalton himself, and is confirmed by the entries in his laboratory note-books of the time; so that Thomson's statement amounts to saying that the atomic theory first occurred to Dalton in the *summer of 1804*. This conclusion appears to us to be entirely discredited by the fact that several detailed tables of atomic weights and lists of atomic symbols, which are dated *September 1803*, occur in Dalton's laboratory note-books, one of these tables being reproduced in facsimile at p. 28 of the work under review, but not referred to by your reviewer.

It must be remembered that Thomson's account of the origin of Dalton's theory was first published in his "History of Chemistry" (vol. ii. p. 291) in 1831, no less than twenty-seven years after his visit to Dalton had been paid. Moreover, in 1850, after the lapse of another nineteen years, he gave a second and totally different account of the origin of the same theory, saying it was founded on the analysis of protoxide and deutoxide of nitrogen (Henry, "Life of Dalton," p. 80).

THE AUTHORS.

THE question is whether Dalton was led to apply the Newtonian doctrine of atoms to the explanation of chemical

phenomena (1) by a consideration of the composition and properties of atmospheric air; or (2) in consequence of remarking the results of the analysis of certain pairs or series of chemical compounds, the composition of which illustrates the law of multiples.

The authors contend for the former view, and adduce the contents of the lecture note-book dated 1810; but these notes of lecture 17 contain evidence of confusion in the statements made by Dalton himself. In these notes he says (p. 14 of the book), "In order to reconcile or rather adapt this chemical theory of the atmosphere to the Newtonian doctrine of repulsive atoms or particulars, I set to work to combine my atoms upon paper," &c. (P. 15), "In 1801, I hit upon an hypothesis." This hypothesis relates to the mutual repulsion of gaseous particles. (P. 16), "Upon reconsidering this subject it occurred to me that I had never contemplated the effect of difference of size. . . . This idea occurred to me in 1805." (P. 17). The different sizes of the particles being once established, "a train of investigation was laid for determining the *number* and *weight* of all chemical and elementary principles which enter into any sort of combination one with another."

So that the atomic theory as applied to chemical combination took shape in Dalton's mind according to this version of the story in 1805. Yet according to another of the note-books, quoted p. 26, he was using symbols to express the atoms of elementary bodies in 1803. The authors notice this conflict of statement, but get rid of it by assuming 1805 to be a clerical error for 1803.

Thomson was probably wrong in attributing the origin of the atomic theory to the study of marsh gas and olefiant gas. But in his exposition of the Daltonian doctrine, prepared only a short time after his interview with Dalton, he illustrates the use of the atomic doctrine by reference to the oxides of nitrogen. This was in his third edition, published 1807. In his sixth edition he introduces the oxides of carbon as well as the oxides of nitrogen. Thomson, therefore, from the time of his interview with Dalton retained the impression that the genesis of the theory was intimately connected with the facts known to Dalton as to chemical combination in multiple proportions, though he was evidently not clear as to the particular case first considered. That it was the oxides of nitrogen which first attracted Dalton's attention is, however, probable from the fact that he refers to them in the following noteworthy passage which occurs in his paper on the atmosphere read at Manchester, November 12, 1802: "These facts clearly point out the theory of the process: the elements of oxygen may combine with a certain portion of nitrous gas, or with twice that portion, but with no intermediate quantity." The authors have succeeded in discrediting the story about marsh gas, but it still remains doubtful whether Dalton's recollections in 1810 of what occurred six or seven years before are more trustworthy than the impressions of Thomson received much earlier, when it is a question as to the order in which various considerations came before his mind in the long course of meditation which led to the adoption of his theory.

YOUR REVIEWER.

An Advance in Röntgen Photography.

SINCE my last communication I have been pursuing the study of the photography of the soft tissues in the living adult subject, and making attempts to see shadows of them on the fluorescent screen. In a previous communication I was able to state that I had accomplished these in the region of the neck, the tongue, hyoid bone, larynx, &c. Proceeding downwards, I have now photographed and seen shadows of the cardiac area. In the photograph the diaphragm is clearly indicated below; the pyriform shape of the cardiac area is well made out, the base downwards, apex upwards, and the right and left borders show the relationship to the spine and ribs.

JOHN MACINTYRE.

179 Bath Street, Glasgow, May 9.

PROJECTS FOR ANTARCTIC EXPLORATION.

ON January 28, 1841, Captain James Clark Ross and his comrades on her Majesty's ships *Erebus* and *Terror*, saw for the first time the giant volcanoes, rising in latitude 78° 30′ S., which bear the names of the only vessels that ever sighted them.

Fifty-five years later we remain in possession of no more information regarding these regions than was brought home by the discoverer. This is a circumstance absolutely unique in the modern history of geography. During these fifty-five years the map of Africa has developed from a *carte blanche* into a well-ordered delineation of mountains, lakes and rivers, even towns and villages the names of which are household words. In the far North the limits of the unknown have been and are still being strenuously pushed back. It is only in the far South that the explorer's march has been stayed, and during the last ten or fifteen years the importance of securing a farther advance in this direction has been given expression to, with increasing frequency and emphasis, by the scientific men of all countries. The latest and most weighty statement on the subject was the resolution of the Sixth International Geographical Congress, drafted in London by the leading geographers of Europe, to this effect:

"That the Congress record its opinion that the exploration of the Antarctic regions is the greatest piece of geographical exploration still to be undertaken. That, in view of the additions to knowledge in almost every branch of science which would result from such a scientific exploration, the Congress recommends that the scientific societies throughout the world should urge, in whatever way seems to them most effective, that this work should be undertaken before the close of the century."

It is clear to all scientific men that, although the recent experimental trips of Scottish and Norwegian whalers to the Antarctic regions have led to some distinct advances in our knowledge, and have rightly occupied a good deal of attention, they leave the question of serious exploration untouched. In the absence of a real expedition, we must continue to eagerly utilise every scrap of information which may be obtained by any means; but such trifles are only of provisional value. The drowning man may, for want of other floats, catch at straws, but the least critical spectator of this proverbial tendency would not argue that a life-belt was therefore unnecessary.

Antarctic exploration, if newspaper reports are to be trusted, has been commenced by the American Dr. Cook, who accompanied Lieutenant Peary on one of his journeys in Greenland, and has now got together a small scientific party on board two little sailing vessels of only 100 tons, with which he hopes to penetrate to the coast of Graham's Land and winter there. Weddell, in 1823, succeeded in reaching 74° 15′ S., in that neighbourhood, one of his vessels being only 65 tons, so that small size does not necessarily mean failure. If Dr. Cook has experienced ice-navigators with him, he will probably be able to effect a landing and collect some useful information. His equipment, however, is, we fear, inadequate to the task he has undertaken, and much must not be expected from it.

A more serious effort is announced as almost ready. It is to be commenced in September this year, under a flag which we believe has not hitherto appeared in polar regions, that of Belgium. The proposed expedition is being arranged by Lieut. A. de Gerlache, of the Berlin Navy, under the auspices of the Royal Belgian Geographical Society, and the expenses, which are estimated at £10,000, are to be met by public subscription. It is said that a large proportion of the money has been promised, the Brussels municipality have voted a grant; but until the whole of the cost is guaranteed, it would be rash to look upon this or any other expedition as a settled affair. A strong scientific staff is intended to accompany the vessel, which will probably try to get south along the east coast of Graham's Land.

In Germany the enthusiasm for Antarctic exploration has been gradually rising, and a strong Committee was appointed at the Eleventh German Geographical Congress, held last year at Bremen, to organise an expedition.

Dr. Neumayer, of the German Marine Observatory at Hamburg, and Herr G. Albrecht, of Bremen, are the Presidents, and the Secretary is Dr. Lindeman, who for many years has, through his editorship of the *Geographische Blätter*, kept the German public fully informed concerning all polar matters. This Committee has recently issued a detailed plan and estimates of a great German expedition to be sent out, not by the Government, but by the nation.

The objects of the expedition are defined as being the study of the meteorological and magnetic conditions of the South Polar area, geodetic observations, zoological, botanical and geological collections, the study of Antarctic ice, and the exploration of the still untouched polar region. For these purposes a station, in which observers can winter, would be fitted up either on the Antarctic continent or on one of the neighbouring islands, and one ship would remain in the nearest safe harbour which could be found, while the second vessel should spend the winter in cruising round the Southern Ocean making oceanographical researches.

The point at which an effort should be made to break new ground within the Antarctic circle was carefully considered, and the region between 70° and 85° E., *i.e.* south of Kerguelen, was selected, for the excellent reason that no previous serious effort has been made south of the Indian Ocean. Special value is placed upon magnetic and meteorological observations at Kerguelen or McDonald Island, because these lie nearly equidistant between the great observatories of Cape Town and Melbourne to west and east, and at a corresponding distance from the observatory of Mauritius to the north.

The recent publication by Dr. Murray, in the *Transactions* of the Royal Society of Edinburgh, of a detailed account of the work of the *Challenger* in the neighbourhood of Kerguelen, with lists of all the species obtained by the collectors on board, will be of service in guiding the biological work of the expedition, while at the same time it furnishes a compact summary of all that is at present known of the marine life and deposits on the edge of the Antarctic.

The German expedition is intended to include two vessels of about 400 tons, no doubt of the type of steam whalers, each carrying four officers, a scientific staff of four, and a crew of twenty-two. The ships would be absent for about three years, and would spend two winters in the Antarctic regions. The total cost is estimated at 950,000 marks, or £47,500, and the German nation is appealed to to find this money, the report of the Committee as published in the *Verhandlungen* of the Berlin Geographical Society concluding:

"The leading Powers of the civilised world appear to be preparing to attempt the solution of the great problem of the geographical conditions of the Antarctic regions. The German nation, always a leader in the solution of geographical problems, cannot possibly lag behind in this contest, the less so because a great and successful voyage of discovery would largely increase the reputation of Germany on the seas, and bring the greatest honour to the German name."

Beside this patriotic sentiment, the practical outcome of which the scientific world and not Germany alone looks for with hope and confidence, we may place a remark from another continental scientific paper, which from the reported refusal of the British Government to consider a proposal for a national expedition, drew the not illogical conclusion that the whole strength of the British Navy had to be brought under requisition for the purpose of making a warlike display before the great Powers. The President of the Royal Geographical Society at a recent meeting observed that "never was there a more favourable opportunity than the present for our Government to demonstrate its confidence in its own naval resources, by detaching a small expedition for special service in Antarctic research." The country is always ready to applaud and support a movement for the honour of the flag and the popularisation of the navy. If a contest between the great Powers is called for by the unthinking of several nations, what contest could be better than friendly rivalry in the advancement of science by maritime exploration? Around the South pole there is room for many simultaneous expeditions. Ross from Britain, Wilkes from the United States, and Dumont D'Urville from France were together in Antarctic waters fifty-six years ago, and the scientific world would gladly hail the early repetition of such history.

The Antarctic Committee of the Royal Geographical Society having been warned that an appeal to Government is not likely to be favourably entertained, has not as yet come to a decision as to its future action. The agitation for a complete scientific expedition will certainly not be allowed to rest. The only want is money; and surely some means can be found to supply this. The necessary amount would never have been missed from the surplus recently at the command of the Chancellor of the Exchequer. If the 600,000 professional men of the British Islands were to subscribe half-a-crown each, the resulting £75,000 would suffice for a very valuable expedition. If a few of the largest daily papers were to start a popular shilling subscription, they might without expense to their proprietors confer a priceless boon on science, and stimulate a healthy excitement in the public. There surely remain in this country some men—at least one man—able to do for the South Polar region what Mr. Harmsworth is so generously doing for the North; and to induce such potential benefactors to make their names great in history should not be an insurmountable task. The last and greatest feat of exploration on our planet may still be done, and allow the nineteenth century to close on a *Terra Cognita*; and the doing of it may still be secured for our country. If the opportunity is not taken now, it may not occur again for us, and the inevitable enrichment of science will redound to the glory of some more far-sighted, more patriotic, and less selfish people. It is an error surprisingly common, and every day becoming more ludicrously erroneous, that only Englishmen are capable of great deeds of daring and perseverance. If we are to retain our pre-eminence in polar exploration, we shall have to fight for it, not with armoured ships costing a million pounds apiece, but with a few old wooden whalers that may be purchased, manned, and equipped for a three years' cruise for less than a tenth part of that sum. Nothing less than a well-equipped scientific expedition can be looked upon as sufficient for the purpose in view.

Mr. T. Gilbert Bowick, of 2 Savile Row, is, as mentioned in a recent number of NATURE, at present completing arrangements for securing a passage for a party of scientific men on a whaling expedition, which is expected to set out in the autumn of this year, and will endeavour to land the passengers near Cape Adare (lat. 71° 45′ S.) in November 1896, returning for them in December 1897. Mr. C. E. Borchgrevink, whose Antarctic voyage is described in NATURE (vol. lii. p. 375), is proposed as the leader of the scientific party, which is intended to include twelve members. The plan of work involves the exploration of the coast of South Victoria Land and shallow-water dredging from a small steamer, which will be left at the winter quarters. Most of the work will naturally consist of meteorological, biological and geological observations near the station at Cape Adare, but a *ski*-journey is projected over the ice-cap in the direction of the magnetic pole. This expedition will, we hope, be undertaken, and if a landing can be made and a station established, the results will be of great value; but such an expedition, useful as it must be, is not sufficient. The alternative seems to be to allow the German and Belgian expeditions the full glory of renewing

serious work in the Antarctic, or to equip an adequate British expedition to co-operate with them by conducting simultaneous observations on the other side of the unknown area. An expedition a few years hence would be much less serviceable, because the value of consecutive work is at most additive, while that of simultaneous work is as the square, or some higher power, of the numbers engaged.

For the first time a south-polar map on a good scale is now available, thanks to the enterprise of Herr von Haardt of Vienna, and his publisher Hölzel. It is on a polar projection, and the scale of 1 : 10000000, approximately 160 miles to one inch. A special feature is made of ice-conditions and ocean currents, and the tracks of all the important southern voyages are laid down. But the most impressive feature is the vast central blank wherein lie hitherto untouched gold-fields of scientific data. HUGH ROBERT MILL.

THE HEIGHT OF LUMINOUS CLOUDS.

IN the *Astronomischen Nachrichten* (No. 3347), Dr. O. Jesse gives a short condensed account of some of the main results that have been obtained from a discussion of all the observations made during the years 1889–91. The full discussion, entitled "Die leuchtenden Nachlwolken," will, however, soon appear in the Publications of the Konig. Sternewarte in Berlin.

Perhaps the most interesting part of this work is that which is based, for the most part, on a series of photographs taken simultaneously at Steglitz, at the Urania Observatory, at Nanen, and at Rathenow, which brings out prominently the fact that the height of these clouds since the beginning of the phenomenon in 1885 has remained for the most part constant. The first table given by Dr. Jesse shows to a remarkable degree this almost constant value obtained for the mean height of the clouds, the actual total mean value being 82·08 kilometres ± 0·009. The apparent constancy in the value thus obtained for the height of these luminous masses is even more surprising when it is remembered that the observations were not made exactly simultaneously, a task by no means easy, so that the fast movements of the clouds were liable to influence the results to some marked extent.

An examination of the facts, however, seems to indicate that if the observations had been made strictly simultaneously, then the zone in which these nocturnal masses move might be considered narrower than the observations have as yet indicated.

As the observations used in this discussion were made for the most part after midnight, the computed value of the height to which they extend can only be said to hold for those clouds observed at this time. As a matter of fact, however, the few observations made before midnight indicate also roughly the same elevation as above obtained, but the paucity of the observations renders impossible any degree of certainty being attached to the result obtained.

Another part of the investigation related to the question as to whether the apparent height of the clouds had always been the same as that deduced from the observations extending over the years 1889–91. To answer this, an examination of all the observations since 1885 was made to see whether the zenith distances for the same depression of the sun below the horizon had always been the same; which would necessarily be the case if the distance of the clouds from the earth's surface be assumed to be nearly always constant.

The observations employed were those made by Backhouse, of Sunderland, in Kissingen, and by Dr. Jesse himself in Steglitz. A condensed form of the table given by the latter is as follows:—

Number of observations.	Depression of sun below horizon.	Zenith distance of the clouds.	Probable error of observation.
	°	°	°
6	9·9	69·9	2·5
9	11·2	77·8	1·4
8	11·8	80·3	0·8
5	12·5	81·7	0·6
7	13·8	85·0	0·5

In the year 1889 the phenomenon of luminous clouds occurred on July 2, and was, fortunately, unusually bright, rendering it possible to make numerous accurate measures; these Dr. Jesse gives in the following table, and compares the results with those given above. The numbers are as follows:—

The Difference of the Zenith Differences on July 2, 1889, from those found in earlier Years.

Depression of sun below horizon.	Zenith distance of the highest point of the clouds. 1889, July 2.	From table.	Difference.	Variation in height for 1° error in measured Z.D.
°	°	°	°	km.
11·4	77·5	78·6	+1·1	6·4
11·7	79·1	79·9	+0·8	7·0
12·6	82·7	82·0	−0·7	8·2
12·9	83·1	82·7	−0·4	8·7

After allowing for the numerous sources of error which might account for some part of the large differences in the fourth column, Dr. Jesse adds that the magnitudes of these are such as to lead him to assume another source of explanation, namely, in the arrangement of the particles composing the clouds themselves. It is probable that the clouds vary very considerably in thickness vertically, which would also affect the differences to some extent; thus with decreasing zenith distances a largely increased impression on the measured zenith distance of the clouds would result.

Setting aside, however, the question of the origin of these small differences, the important main result of the investigations still remains intact, namely, that from the years 1885–91 the luminous clouds have always had nearly the same mean height, namely 82 kilometres, or about 51 miles. W. J. S. L.

THE BISHOP OF RIPON ON HUXLEY AND SCIENCE.

AT a meeting convened by the Leeds Philosophica and Literary Society, held a few days ago, a resolution was unanimously adopted appointing a Committee, consisting of the Mayor, the members of the Council of the Philosophical and Literary Society, and all others who volunteered to join, for the purpose of raising subscriptions in aid of the Huxley Memorial Fund. We rejoice at the formation of the Leeds Committee, but another cause of gladness is the address delivered by the Bishop of Ripon in support of the object for which the meeting was held. In no uncertain voice, Dr. Boyd Carpenter declared himself a supporter of the principles which guided Huxley's noble life, and proclaimed the righteousness of scientific truth. It is not often that dignitaries of the Church speak so boldly for science as Dr. Carpenter did at the Leeds meeting; and on this account, and also because many of our readers will be glad to see this public recognition of Huxley's integrity of thought and purpose, we gladly print a report, though an abridged one, of the address.

It would not be surprising to discover there are many in this meeting who would be prepared to point out one or two special and specific objections or difficulties they have felt in regard to Prof. Huxley's teaching. I think, however, you will agree with me that if we demand complete harmony of opinion, that stupid unanimity which betrays either ignorance or thoughtlessness, before we dare to speak in honour of any one whose

name has become great, we shall be in the position of those who have nobody to honour and no names to commemorate. I feel, therefore, though all may differ in some points from Prof. Huxley, there is not one of you who cannot with the most simple honesty of purpose take part in this meeting. I am here to do honour, as an English citizen, to the name of a great Englishman. We who belong to the English race are, I suppose, sometimes slightly jealous for its greatness in certain departments. We feel we are outstripped by our Teutonic neighbours in the pathways of investigation. We feel we are outstripped sometimes by our American neighbours in the process of invention. So that whenever we have a great man we might as well cherish him, and make the most of him. Nations are great from a variety of causes. Their geographical position contributes to their greatness; their fertility and wealth of soil, and their racial qualities play a large part in the conspicuous or obscure place they are able to fill on the platform of the world. But the element which constitutes the happiest source of national greatness is the possession of great men. Great men are in the nation what the highest peaks are in the geography of the land—they mark the high level to which the people are capable of attaining; they are fertilising water-sheds pouring out their rich stores on the great plains below them. A nation ought, therefore, to reverence its great men, for they are not merely the expression of national greatness, but high ideals producing a reaction, an enthusiasm, an ambition in the hearts of those who come after them. I think you will agree with me that Huxley was entitled to the epithet "great." He was a strong man among strong men. But it was not simply that he attained immense eminence in the walk of life to which he dedicated his powers, he possessed also an unique power of being able to look with a sympathetic and appreciative eye on other walks and realms of science than those which were peculiarly his own. And, therefore, he was able to take a larger outlook than many a man who, shut up in his laboratory, or working in the fields, or observing through his telescope, remained limited to one particular sphere of scientific work. And because Huxley possessed that power, he became what he himself humorously described, "a maid of all work, a gladiator-general for science." That position was a worthy and a useful one. He also possessed a marvellous gift of lucid exposition. He was able to make clear to the minds of those who were not scientific, thoughts and ideas which were eminently scientific. For these reasons we have a right to claim him as great—great in English life, great by virtue of his devotion to science, great by virtue of that wide appreciativeness he brought to bear upon it, and great in the power of being able to expound to others. I am here as a friend of knowledge, to do honour to one who enlarged its borders. I know there are many—though they are a diminishing quantity—who are disposed to look somewhat askance at the progress of science. In the history of the world it has been only too obvious that men through timidity have been afraid of the advance of knowledge, and it is not surprising to find that in the nineteenth century, with all its vaunted enlightenment, that spirit of timidity should have found expression. What men own and feel to be dear to them they cherish, and God forbid they should be hindered from cherishing it. Many a man looks on science very much in the same way as a woman who hugs her infant to her breast looks on the doctor who draws near, and in regard to whom she entertains some very unreal but still natural suspicion. When men hug to their bosom the faith which is dear to them, and which they feel to be bound up with their dearest hopes, one can quite understand their clinging more closely and looking apprehensively at the progress and advance of science. But men are beginning to understand that it cannot be in the nature of things that facts and truths will contradict those things which are nearest and dearest and most essential to men. And because we are men we claim it to be our privilege and our responsibility—I may almost say we claim it to be part and parcel of our probation in this world—to follow truth wherever it leads us. It is not, therefore, our duty to encourage a timidity which, if it were encouraged, can only lead to a fatal obscurantism. The progress of knowledge can only deepen and intensify our attachment to the things which are true, and things which are true cannot be out of harmony with the things round about us. The child, cherished and reluctantly parted with, is restored to us by his doctor healed and saved. Religious truth, in one sense, must always wait on scientific truth, and religious truth must often change its form at the bidding and on the information given it by scientific truth. I am not aware that in the history of scientific progress religion has ever lost; the precious jewels have always been restored to her in richer and nobler settings. Because I believe that the advancement of knowledge must be for the benefit of mankind, and could not in the long run be hostile to any of the things most precious to us, I stand here to-day to do honour to one who laboured in the cause of the advancement of knowledge, and did so much to make it the heritage of all people. And, lastly, I am here to do honour to one, for whose truthfulness of character I have the profoundest admiration. Prof. Huxley had what might almost be called an exaggerated tenacity for the thing which he believed to be true, and a reluctance to surrender the truthfulness of his spirit at the bidding of any man or any authority. "But," some may say, "he was antagonistic." This is not the place nor the occasion to speak of Prof. Huxley's attitude towards Christianity, or even towards faith; but it should be remembered that the antagonism of his spirit was far more called out by the unfortunate attitude adopted by some who professed and called themselves Christians than by anything in its (Christianity) own nature. The moral and lesson of it is perfectly clear. A man may show himself the antagonist of other men's errors and of other men's methods without in the least degree being hostile to those precious things on which the hearts of men were wont to repose. Prof. Huxley was not one to knock from under any cripple's arm the crutch that enabled him to walk. While he spoke the language which seemed to him to be justified against those whose methods he could not approve, his language at other times was of that childlike simplicity, that entire modesty, and that natural humility which belonged to all thinking, educated, and reasonable men. Because he seemed to be setting before the world, even when we did not agree with him, an example of simplicity and truthfulness of disposition, I am here to say I honour him. We all desire to honour one who, great in his powers, sought to extend the borders of knowledge, and thus to add to the comforts, the joys, and the assurances of life, and who showed a character so simple, steadfast and truthful.

NOTES.

Prof. Victor Meyer has been elected a corresponding member of the class of mathematics and physics of the Berlin Academy of Sciences.

Major P. A. MacMahon has been appointed to represent the London Mathematical Society at Lord Kelvin's jubilee commemoration in Glasgow.

The Bavarian Academy of Sciences at Munich has awarded the Liebig Gold Medal to Prof. F. Stohmann, Professor of Agricultural Chemistry in Leipzig University, and silver medals to Prof. B. Tollens, Professor of Agricultural Chemistry in Göttingen University, and Prof. P. Sorauer, of Berlin.

Mr. Frederic Ducane Godman, F.R.S., has been elected a Trustee of the British Museum.

The annual visitation of the Royal Observatory, Greenwich, will take place on Saturday, June 6.

Mr. G. Griffith left Liverpool for Toronto on Saturday, to make arrangements for the meeting of the British Association in 1897.

The exhibition galleries of the British Museum, Bloomsbury and of the British Museum (Natural History), Cromwell Road will be opened to the public on Sunday next from 2.30 to 7 p.m.; and will be opened on subsequent Sunday afternoons until further notice.

A special general meeting of the Geological Society will be held on Wednesday, May 20, in order to submit to the decision of the Fellows certain resolutions of the Council regarding a proposed transference of a portion of the Society's collections to the Trustees of the British Museum.

THE *Journal of Botany* states that Herr V. F. Brotherus, of Helsingfors, has just started on a botanical journey to Central Asia; he is going by way of Samarcand and Tashkend to Thian Shan, with the special purpose of investigating the mosses of the highlands of Issikkoul. The district is a new and promising one.

THE *Bulletin de la Société Botanique de France* records the death, on December 31, 1895, of M. R. P. Delavay, Roman Catholic missionary at Yunnan, at the age of sixty-two. Since his arrival in China in 1867, he had been a most industrious explorer of the flora of that country, having sent home to the Museum of Natural History in Paris more than 4000 species, nearly half of them new. According to the *Bulletin*, he described for the first time about fifty species of *Rhododendron* and *Pedicularis*, and about forty of *Primula* and *Gentiana*.

IN connection with next year's country meeting, to be held at Manchester, under the presidency of the Duke of York, the Royal Agricultural Society will offer two prizes of £100 and two prizes of £50 for self-moving vehicles for light and heavy loads. In both classes the self-moving vehicles are to be propelled exclusively by mechanical means. The points to which the special attention of the judges will be called are: due regard to the convenience of the public; ease of handling, with special reference to stopping, starting, and steering; economy in working, price, simplicity, strength of design, and weight of vehicle.

OUR American correspondent writes, under date May 1:—"Columbia College will send a band of naturalists, under the leadership of Prof. Bashford Dean, to explore Puget Sound this summer, leaving New York June 10. Three zoologists and one botanist will accompany the party. The deep-sea work will be done with the aid of the United States Fishery Commissioners' vessel *Albatross*. The region is almost unexplored, and important results are expected.—A delegation of prominent scientific men appeared before the Finance Committee of the United States Senate a few days ago, to urge legislation favouring the metric system, but were informed by Senator Sherman that it was probably too late to accomplish anything at this session of Congress."

THE provisional programme of the International Congress of Psychology, to be held in Munich on August 4 to 7, under the presidency of Prof. Dr. Stumpf, shows that there is likely to be a plethora of papers on all branches of the science of mind. Eminent psychologists from many parts of the world have sent papers, among those who have done so being M. E. Bértillon (Paris), Prof. Bernheim (Nancy), Dr. Alfred Binet (Paris), Prof. Delboeuf (Liège), Prof. H. Ebbinghaus (Breslau), Prof. Sigmund Exner (Vienna), Prof. Stanley Hall (Worcester, Mass.), Dr. E. Hering (Prague), Prof. P. Janet (Paris), Prof. Th. Lipps (Munich), Prof. W. Preyer (Wiesbaden), Prof. Th. Ribot (Paris), Prof. C. Richet (Paris), Prof. H. Sidgwick (Cambridge), Mr. G. H. Stout (Cambridge), Dr. Carl Stumpf (Berlin), and Dr. W. Wundt (Leipzig). Details as to the arrangements of the Congress, which promises to be truly international in membership, and broad in scope, may be obtained from the General Secretary, Dr. Frhr. von Schrenck-Notzing, Max Josephstr. 2 I, Munich.

WE learn from *Die Natur* of April 26, that the Imperial Russian Geographical Society has sent to the northern boundaries of Russia a large number of notices relating to the possible descent of Herr Andrée's polar balloon in Russian territory. The inhabitants are exhorted not to be frightened at the balloon, to treat the occupants, in case of need, with all respect, and to conduct them to the nearest Government authorities; the notice also states that any expenses incurred will be repaid. It is further requested that if the balloon be sighted, information should be given of the direction in which it was going. The document contains representations of the balloon, both in flying and falling conditions.

PROF. UGOLINO MOSSO (*Atti della R. Accad. dei Lincei*) describes a series of observations on human respiration at high altitudes, performed with the object of testing whether the quantity of carbonic acid exhaled in breathing is in any way affected by the rarefaction of the air. For this purpose a number of soldiers were tested in the course of an expedition on the slopes of Monte Rosa, and further experiments were made by the author on himself in an experimental chamber at the Physiological Institution of Turin. These observations prove that the quantity of CO_2 expired by a man at an altitude of 6400 metres, differs but slightly from that expired at 276 metres above the sea-level. Prof. Mosso subjected himself to pressures as low as 34 cm. of mercury without feeling any ill-effects, the oxygen present being still sufficient for purposes of respiration; but when the pressure was reduced to 30 cm., the author began to find his faculties impaired, and in one case felt a great want of breath. After about eleven or twelve minutes, he became incapable of making accurate observations, and the experiments had to be discontinued.

THE Kew Observatory Committee of the Royal Society have recently issued their Report for the year 1895. The Chairman of the Committee is Mr. F. Galton, and the Superintendent of the Observatory is Dr. C. Chree. At the suggestion of the Council of the Royal Society, the title of the Committee has been changed during the year: the change consists in the insertion of the word "observatory" and the omission of the word "incorporated." The magnetographs have been kept in constant operation throughout the year, but no very exceptional disturbances were registered during that period. An analysis of the declination and horizontal force results for selected "quiet days" during 1890-94 has been published in the Report of the British Association for last year. The self-recording meteorological instruments have also been in regular action during the year, and the observations have been transmitted, as usual, to the Meteorological Office. Sketches of sun-spots were made on 159 days, and the groups numbered according to Schwabe's method. Various experimental investigations have been carried on, in addition to the regular routine work, relating to fog, atmospheric electricity, platinum thermometry, &c. A sum of £100 was obtained from the Government Grant Committee for the purpose of making experiments on the behaviour of platinum thermometers; these are found to possess advantages even in dealing with some ordinary temperatures which require to be read at a distance from the spot where they are recorded. The total number of instruments verified, and of watches and chronometers rated, shows a considerable increase.

IT was not to be supposed that the astonishing announcement made by Jörgensen and Juhler as to the development of yeast cells from the *Aspergillus oryzæ* would go unchallenged; but it must, at any rate, be a satisfaction to these investigators that the inquiry has fallen into such skilled hands as those of Messrs. Klöcker and Schiönning, both assistants in the famous Carlsberg Laboratory. These gentlemen have repeated in every conceivable manner the experiments of Jörgensen and Juhler, and have even greatly extended the scope of their original observations; but in no single instance have they obtained any evidence of the development of yeast cells from moulds. It would appear that too much weight has been given to mere microscopical evidence, and not sufficient attention bestowed upon the acquisition of pure cultures. Perhaps the most interesting efforts to decide this knotty question were those investigations made with various fruits growing in a natural condition on trees,

investigations suggested by some early work of Pasteur, and also Chamberland, published in 1879. As is well known, moulds and yeasts are present side by side in large numbers on various fruits, such as plums, cherries, grapes, &c. ; and Messrs. Klöcker and Schiönning determined to prove, if possible, that their simultaneous presence is a mere coincidence, and not evidence of the development of yeast cells from moulds. Comparative examinations were therefore instituted of numerous fruits, some of which were simply gathered from the tree, whilst in other cases they were only examined after having been carefully excluded from the outside air for some time by enclosing a small fruit-bearing branch in a specially constructed glass case. Thus, for example, on none of the plums protected from the surrounding air could any yeast cells be discovered, although moulds were present in abundance, whilst on as many as 50 per cent. of those exposed to the air, yeast cells were found along with the moulds. Messrs. Klöcker and Schiönning contend that they offered the moulds the most natural and favourable opportunities for the production of yeast cells in these glass cases, which could be devised, but they failed in every case to make their appearance. Dr. Jörgensen himself, it is only fair to add, appears to be somewhat baffled by the nature of his observations, and in his most recent communication on the subject, frankly confesses that this elaboration of yeast cells from moulds must at present be regarded as a process in which chance appears to play an important part, and the circumstances attending which we are yet quite unable to master !

M. Moisson is reported (*Centr. Zeit. für Opt. u. Mech.*, xvii. 6) to have discovered a substance harder than the diamond in the form of a compound of carbon and boron, produced by heating boracic acid and carbon in an electric furnace at a temperature of 5000°. This compound is black and not unlike graphite in appearance, and it appears likely to supersede diamonds for boring rocks, cutting glass, and other industrial purposes. It will even cut diamonds without difficulty, and it can be produced in pieces of any required size.

According to Prof. J. C. Arthur, the popular idea that of the two seeds in the spikelet of wild oat, one germinates at once, and the other only after a year, has no foundation in fact. But this is true of the two seeds in the fruit of the "cockle-bur," *Xanthium canadense* and *strumarium*. The cause of the difference in the action of the two seeds appears to be constitutional and hereditary.

Only three species of Bears have hitherto been generally recognised by naturalists as occurring in North America, namely the Polar Bear, Black Bear of the Atlantic States, and Grizzly Bear of the Western States, though others have been proposed. In his recently issued "Preliminary Synopsis of the American Bears," Dr. C. Hart Merriam takes a very different view. Dr. Merriam raised the number of American Bears to no less than eleven, dividing those of the "grizzly" type (*Ursus*) into six species, and those of the "black" type (*Euarctos*) into four. Dr. Merriam's synopsis is illustrated by figures of the skulls of the different species.

M. E. A. Martel, President of the Speleological Society (Paris), has visited and surveyed the Mitchelstown Cavern in Ireland, and reports on it in the *Irish Naturalist* for April. Although discovered over sixty years ago, and well known to tourists, this cavern had never before been properly explored. Its chief peculiarity consists in its extensive ramifications, which in one part follow the jointing of the limestone so regularly that the plan looks like that of the streets of a town. The total length of the cave exceeds a mile and a quarter, so that it is probably the longest in the British Isles. Mr. Lyster Jameson furnishes a report on the living animals found in this and other Irish caves, which mostly fall into three categories—those inhabiting the entrance to the cave as a hiding-place, those that have accidentally been brought in, and those that form its normal fauna. The last consist of a spider and two *Collembola*, and are interesting as constituting the first true cave-fauna recorded in the British Isles. A description of these forms appeared in previous numbers of the *Irish Naturalist* and of *Spelunca*.

We have received from the Geological Survey of Norway a set of their Reports for the years 1893, 1894, and 1895, published by H. Aschehoug and Co., Christiania, at prices which bring them within the reach of every one who may be interested in the subjects of which they treat. The Reports are highly creditable to such a sparsely-peopled country as Norway, and to the Director of its Geological Survey, Dr. Hans Reusch, who seems to thoroughly appreciate the wants of his practical countrymen. As the country apparently possesses few organised public departments, the publications of its Geological Survey are comprehensive in their scope, covering questions of agriculture, forestry, climate, irrigation, soil, and orography, as well as of mining and geology. The economic aspects of the building-stone and mining industries are well considered and presented to the people for their deliberation and guidance, as well as the purely geological questions of stratigraphy and petrography. Palæontology, however, is conspicuous by its absence. One of the largest of the Reports deals with roofing-slates, flagstones, and with steatite as a building-stone. It is a pity that the vocabulary of the language is not rich enough to have different words for slate and schist (*Skifer* represents both); but our own language is equally faulty, or rather misapplied, when the word slate is used in referring to Stonesfield slate, as well as to that of Ballachulish or Llanberis.

In one of the Reports (No. 14) referred to in the foregoing note, there is an interesting communication by A. Helland, on the depths of the lakes in Jotunheim and Thelemark, as ascertained from soundings by himself and others ; but unfortunately all of them have been made in the line of the length of the lakes, none of them transversely, thereby missing a most important clue to the explanation of their origin. He gives longitudinal sections of four of the principal lakes in Jotunheim, but the irregularities in the bottoms are not favourable to the glacial erosion theory which he supports ; transverse sections would probably prove more instructive. Of the forty-two lakes mentioned, no less than twenty-three of them have their bottoms below sea-level. The following series of figures represents the number of feet below sea-level of the first twelve, viz. 1417, 1085, 715, 712, 593, 568, 528, 456, 456, 456, 361 and 190. The first is the Hornindals Vand, the surface of which is only 177 feet above sea-level, but the bottom is 1417 feet below it ; the second is the Mjösen Vand, the surface of which is 397 feet above, and bottom 1085 below, sea-level. The great depth below sea-level seems to militate against the theory that they were eroded by ice.

In the *Bulletin* of the Academy of Sciences of Cracow, Dr. L. Natanson contributes a long and elaborate communication on "The Laws of Irreversible Phenomena," and L. Birkenmayer describes a series of observations on the length of the seconds' pendulum in the neighbourhood of Cracow.

Prof. J. M. Coulter publishes, in the "Contributions from the United States National Herbarium," a revision of the North American species of *Echinocactus*, *Cereus*, and *Opuntia*. Fifty-two species are enumerated of the first genus, eighty-two of the second, and 101 of the third ; a good many of these are now described for the first time.

Mr. James Hornell, Director of the Jersey Biological Station, is issuing a series of Microscopical Botanical Sections,

similar to those in Zoology already published. The series will consist of twenty original photo-micrographs, accompanied by descriptive letter-press and illustrations. The subjects included in the part we have received comprise longitudinal and transverse sections through the underground bud of *Equisetum*, transverse sections through leaf-buds of the Elm and the Ash, cuticle of *Araucaria*, longitudinal section through node of Sycamore, longitudinal section through flower-bud of Peony, transverse section through fruit of Date-palm, transverse sections through flower-buds of *Iris* and *Lilium*.

MESSRS. MACMILLAN AND CO. will shortly publish "An Intermediate Course of Practical Physics," by Prof. Arthur Schuster, F.R.S., and Dr. C. H. Lees. The book will set forth the course of instruction in practical physics followed in Owens College during the last five years. The explanations having thus passed through the refining fire of a physical laboratory, have been cleared of all the obscurities which tease the intelligence of the average student. The book was primarily designed for use in preparing for the Intermediate B.Sc. and First M.B. examinations of the Victoria University, but the requirements of other Universities are so nearly identical that it will appeal to a much wider circle of students.

DURING the year 1895 the Albany Museum, Grahamstown, made excellent progress. From Dr. Schönland's report we gather that, owing to the large influx of specimens, the capacity of the museum is overtaxed, and the erection of a new building has become a matter of absolute necessity. The Government have therefore been asked for a sum to devote to this purpose, and, considering the value of the collections and the useful work the museum is doing, and can still more effectually perform in a suitable building, it is hoped that the grant desired will be regarded as a judicious outlay. Owing to the rapid growth and increasing value of the herbarium formed in connection with the museum, the Committee think it desirable that the expenses incurred by its management should be borne by a fund apart from the general revenue of the museum, and they have, therefore, asked the Government to grant an annual sum of £100 for this purpose. Dr. Schönland has been experimenting with formaline as a substitute for spirits of wine in preserving specimens. The results obtained have been satisfactory, but he is afraid to discard spirits of wine until he is sure that formic aldehyde is a perfectly stable compound, and will keep for a considerable length of time in the hot climate in which the museum is situated.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♀), two Sambur Deer (*Cervus aristotelis*, ♂ ♂) from India, presented by Mr. Greswolde-Williams; a Brown Capuchin (*Cebus fatuellus*) from Brazil, presented by Mrs. J. Hicks; three young Cheetahs (*Cynælurus jubatus*) from Somaliland, presented by Mr. Kenneth Foster; two West Indian Agoutis (*Dasyprocta cristata*) from the West Indies, presented by Mr. W. Weldon Symington; a Chinese Goose (*Anser cygnoides*, ♂) from China, presented by Mr. L. G. Leverson; a White-crested Cockatoo (*Cacatua cristata*) from Moluccas, presented by Mrs. Crofts; two Pennant's Parrakeets (*Platycercus pennanti*) from Australia, presented by Mr. Clifford Brooks; a Porose Crocodile (*Crocodilus porosus*) from Java, presented by Mr. A. W. Richmond; two Bennett's Wallabys (*Halmaturus bennetti*) from Australia, a Spotted Ichneumon (*Herpestes nepalensis*), two Hamadryads (*Ophiophagus elaps*) from India, deposited; an Entellus Monkey (*Semnopithecus entellus*, ♀) from India, a Great Anteater (*Myrmecophaga jubata*), two Picui Doves (*Columbula picui*) from South America, two Blue-headed Pigeons (*Starnœnas cyanocephala*) from Cuba, two Auriculated Doves (*Zenaida auriculata*) from Chili, four Cape Doves (*Œnas capensis*) from South Africa, two Crowned Pigeons (*Goura coronata*) from New Guinea, a Southern Fruit Pigeon (*Crocopus chlorogaster*) from India, a Nicobar Pigeon (*Calœnas nicobarica*) from the Indian Archipelago, purchased.

OUR ASTRONOMICAL COLUMN.

COMET SWIFT, 1896.—The following is Dr. Schorr's ephemeris for Berlin midnight (*Ast. Nach.*, 3349).

	R.A. h. m. s.	Decl. ° ′	Brightness.
May 14	1 30 19	+67 33·9	0·26
16	1 15 49	68 38·1	
18	1 1 20	69 31·9	0·20
20	0 46 52	70 16·9	
22	0 32 32	70 54·3	0·16
24	0 18 19	71 25·1	
26	0 4 14	71 50·3	0·12
28	23 50 16	72 10·5	
30	23 36 28	+72 26·3	0·10

The path of the comet lies in the northern part of Cassiopeiæ until May 25, when it passes into Cepheus.

A PHOTOGRAPHIC TRANSIT CIRCLE.—Many attempts have been made to replace the observer of star transits by a photographic plate; but as most of them require the plate to register star-trails, it is impossible in this way to record the fainter stars. Dr. H. C. Russell has recently proposed another method, which he believes will be capable of giving star positions with much greater accuracy than is possible with the existing transit circles, and is at the same time good for the fainter stars. The instrument is virtually a photographic telescope of thirteen inches aperture, mounted alongside a visual telescope in a rectangular box, which turns on trunnions within a polar axis of the "English" form. An electrically-controlled driving clock, and circles for declination and right ascension complete the instrument. On the scale suggested the circles may be large ones, so that declinations may be read by microscopes to 0″·1 and right ascensions to 0·01 sec. The polar axis would be adjusted by the familiar processes, and the instrument would be collimated like an ordinary transit circle; the line of collimation of the star camera must also be made parallel to that of the telescope. The telescope would be set on the desired star before the meridian, and the star would be constantly kept on the cross wire while the plate was being exposed; meanwhile the R.A. would be read off by a second observer noting the times at which the divisions of the circle pass a fixed microscope, the relation of each division to the meridian being very accurately determined. A third observer would read the declination circle. The instrument would next be reversed in the polar axis, and the observation repeated. If there were no collimation errors or flexure due to the position of the telescope the photographic images of the star would be superposed, and if they are not, the point midway between the spots may be assumed to be the mean of the unknown errors. There would of course be two images of any stars, except the guide star, that might be in the photographic field, and their positions relative to the guide star would be determined by measurement of the photograph. The advantages specially claimed are (1) the observation does not depend upon a flying shot at the bisection of a stellar image; (2) at least a partial elimination of unknown errors is effected; (3) the determination of R.A.'s with equal and extreme accuracy for stars in all declinations.

MR. TEBBUTT'S OBSERVATORY.—The report for 1895, which we have just received from Mr. Tebbutt, of Windsor, N.S.W., is a splendid illustration of what can be accomplished almost single-handed by an enthusiastic astronomer. Not less than 957 transits of stars were observed during the year, and this in addition to a varied series of other observations. A large number of occultations of stars was observed, and what may be regarded as a feat in this class of work was accomplished on August 29, when both phases of the occultation of the fifth magnitude star B.A.C. 6127 were observed in full sunlight. The micrometric work includes numerous measures of the positions of the minor planets Hebe and Ceres, and of seventeen double stars which are of peculiar interest. Jupiter's satellites and certain variable stars also received attention, and the various meteorological phenomena were recorded. Eleven papers on the results of the astronomical work were published during the year.

THE ROYAL SOCIETY CONVERSAZIONE.

Few conversaziones of the Royal Society have exceeded in interest the one held on Wednesday of last week. Many of the exhibits were very striking, while all of them presented novel features. Physical science predominated, and Röntgen photography attracted a large share of attention throughout the evening. Mr. A. A. C. Swinton had an elaborate exhibit to illustrate experimentally the production of Röntgen rays, and the visible and photographic effects produced by them. By means of several binocular cryptoscopes, all who so desired were able to see shadow pictures of the bones in the living body, and of objects enclosed in opaque boxes, while Röntgen photographs of the hands of many persons were taken during the evening.

Mr. Herbert Jackson's demonstration of the use of phosphorescent materials in rendering Röntgen rays visible, brought out the supremacy of potassium platino-cyanide as the salt for phosphorescent screens. The tube used to produce the rays was a slight modification (described in the *Proceedings* of the Chemical Society) of a tube originally introduced by Mr. Crookes to illustrate the heating effect of kathode rays. These are brought to a focus at the centre of curvature of the concave kathode, whence they proceed in nearly a straight line to a platinum plate, from the surface of which they are apparently scattered in all directions. The rays penetrating the glass were caused to fall upon phosphorescent bodies and were rendered visible, thus showing the different intensities of response of these bodies to such rays. By means of a large phosphorescent screen covered with platino-cyanide of potassium, all the effects seen individually with a cryptoscope were viewed by a number of people at the same time.

Mr. Sydney Rowland exhibited a series of "skiagrams" illustrating the applications of the "new photography" to medical and surgical diagnosis. The following analysis, based on a record of some fifty cases, is useful as showing the branches of surgery in which the new process will probably be found of most use. About 20 per cent. of these include the discovery and location of foreign bodies, needles, bullets, &c., lodged in soft tissues, and in one case a coin lodged in the intestine, which caused troublesome symptoms. In one of these cases two previous operations had been fruitlessly performed. 15 per cent. of the cases were instances of pathological conditions of the elbow-joint of more or less obscurity, on which new and unexpected light was thrown by the diagnosis thus obtained. In 10 per cent. of the cases the object in view was the determination of the extent and distribution of tuberculous lesions in bone. Various ankyloses and deformities of the bones and joints of the extremities have made up the remainder of the cases.

A self-testing resistance box and bridge were exhibited by Mr. E. H. Griffiths, F.R.S. This apparatus presented many novel features, the chief advantages being as follows:—(1) The observer can (without use of standards, &c.) ascertain accurately, and quickly, the comparative errors of all the coils, including those in the ratio-arms. (2) An exact calibration of the bridge wire can be made by means of the box itself. (3) The temperature of the coils can be accurately determined. (4) The resistance of leads to any object is self-eliminated. (5) Resistances from 0·00001 ohm to 10^5 ohms can be directly read by a null method, without observation of galvanometer swings. (6) All coils after adjustment have been heated to a red heat, and are thus very free from strain, &c. (7) There are special arrangements for securing constancy of all plug contacts, &c.

A resistance box, standard coils, and wire bridge were exhibited by Mr. F. W. Burstall. The resistance box was of the dial pattern, wound in bare platinum silver wire on strips of mica, the wire being immersed in pure mineral oil; there were five dials, ranging from $\frac{1}{10}$ ohm to 1000 ohms, and four pairs of proportional arms. The four standard coils were of similar forms, but were intended to be used with mercury cups. In conjunction with Mr. H. R. J. Burstall, the same exhibitor showed bare wire resistance thermometers for use in vessels under high pressure. The measuring wire was wound on mica plates carried by slender columns from a metallic plug which was screwed into the vessel. The change of resistance was measured by comparing the drop of E.M.F. over the measuring wire, with the drop over a standard coil put in series with it and a battery. A thermometer was exhibited which had been in a steam superheater for more than a week continuously, at a pressure of 160 lb. per square inch. Both these exhibits should prove of great assistance in electrical and thermometric measurements.

New apparatus for measuring the magnetic permeability of iron or steel was shown by Prof. Ewing, F.R.S. The apparatus allows measurements of permeability to be made with samples in the form of short rods, and greatly simplifies the process. It acts by making a magnetic comparison between the rod to be tested and a standard rod, the magnetic qualities of which have been determined beforehand. The magnetic detector, which shows when the two rods have the same induction, consists of a compass needle placed in a gap in an iron bar joining the two yokes. From its analogy to the Wheatstone Bridge, the author proposes to call the instrument a Permeability Bridge. It forms a companion instrument to the hysteresis tester exhibited last year.

A flint glass prism of nine inches aperture and 45° refracting angle was exhibited by Mr. J. Norman Lockyer, C.B., F.R.S. The prism has been constructed by the Brothers Henry, of the Paris Observatory, and will be used as an objective prism for photographing the spectra of stars. Mr. Lockyer also showed the following:—Photograph showing positions of coronal spectrum rings in the total eclipse of the sun, April 16, 1893. The original negative was taken by Mr. Fowler, at Fundium, West Africa, with the 6-inch prismatic camera near the middle of totality, with an exposure of forty seconds. In addition to the images of a number of prominences, there were portions of rings representing the radiation spectrum of the corona. The brightest of the rings corresponds to the well-known corona line 1474 K, but the others have not been previously photographed. All the rings are most intense in the brightest coronal regions, near the sun's equator.—Photographic spectra of α Cygni, γ Cygni, and Arcturus. The photographs were taken at South Kensington with a 6-inch objective prism of 45°, and illustrated the difference between stars of increasing and stars of decreasing temperature. Arcturus is a cooling star, almost identical with the sun, while α Cygni differs very widely from the sun and is getting hotter. The spectrum of γ Cygni, like that of Arcturus, consists of a very large number of lines, but as many of the more prominent lines agree with those of α Cygni, and are absent from the solar spectrum, this star must be classed with those of increasing temperature.—Photographs showing the spectra of helium and gas X in relation to the spectra of Orion stars. The lines of the two gases were arranged in the series deduced by Messrs. Runge and Paschen, and their distributions in the spectra of Bellatrix, Rigel, δ Orionis, and Spica were shown.—Photographic map of the spectra of metals of the iron group. The map extended from wave-length 3900 to 5900, and included the spectra of iron, manganese, cobalt, nickel, chromium, and uranium, as shown at the temperature of the electric arc. Rowland's map of the solar spectrum formed the term of comparison, so that the wave-lengths of the lines could be read off directly from the map.

Mr. F. McClean, F.R.S., exhibited photographs of the spectra of twenty-three characteristic helium stars. These stars correspond to Class I.*a* of Lockyer (*Phil. Trans.*, December, 1892), who further attributed their spectrum to helium (*Proc. Roy. Soc.*, May 9, 1895). The hydrogen and helium were indicated below the scale of wave-lengths. The enlargement was 8½ times the original negatives. Mr. McClean also showed photographs of the spectra of six stars of the third magnitude, illustrating the transitions from type to type.

Another spectroscopic exhibit was by Prof. Hartley, F.R.S., whose subject was, however, terrestrial. He showed a series of photographed spectra illustrating an investigation of the Bessemer flame, as seen at the North Eastern Steel Co.'s Works, at Middlesbrough-on-Tees, in which the presence of the rare element gallium was recognised by a single line in its spectrum, and separated from both the metal and the ore of the district.

A remarkable exhibit, by Mr. Joseph Goold, consisted of steel tuning-bars and synchronising sound-generators. The new synchronising sound-generator was a vibrating rubber having the pitch or vibration-period of the note to be elicited. The separate partial-tones were thus developed singly with remarkable power and sweetness. These appliances have already led to the further discovery of *vibration-axes and -vortices*, examples of which were exhibited.

The rapid photographic printing machines, exhibited by Mr.

W. Friese Greene, turned out prints at a rate almost beyond belief. The machines are for the production of prints wholly or partly by photography, and their chief object is to effect a very rapid production of copies adapted for use as illustrated supplements, newspapers or magazines, or for other purposes where a large number of copies of the same picture, design, or other objects are required. A roll of rapid bromide paper was fed in at one end of each machine, and finished prints were turned out at the other end at the rate of two or three thousand an hour. Mr. Greene also showed a new type-setting machine dispensing with movable types.

Instantaneous photographs of splashes were shown by Prof. Worthington, F.R.S., and Mr. R. S. Cole. These photographs were taken each with an electric spark giving an exposure of less than 3 millionths of a second (see NATURE, vol. l. p. 222.) The spark could be so timed as to pick out any desired stage of the splash within limits of error not exceeding, as a rule, about 2-thousandths of a second. In this way the progress of a great variety of splashes has been followed in minute detail. Specially interesting were those which illustrated the formation of a bubble, and those which showed how the nature of the disturbance produced by the entry of a solid sphere depended on the condition of its surface.

By means of the colour patch apparatus exhibited by Captain Abney, C.B., F.R.S., it becomes possible to throw on a screen, or on a photographic plate, the image of a luminous object in monochromatic light. An image is first formed on the face of a prism or grating by means of a lens of proper focal length, placed close to the slit of the spectroscope. The spectrum is formed in the usual way, and the colour in which the image of the object is to be formed is allowed to pass through a slit placed in the spectrum. A second lens placed close to this slit forms the image in monochromatic light of the image on the prism or grating on a screen or photographic plate.

Prof. Roberts-Austen, C.B., F.R.S., showed his interesting modifications of an experiment of M. Charles Margot. A wire of aluminium was raised, by a current of 30 amperes, to a temperature far above the melting point of aluminium, but a film of oxide on its surface prevented the wire from breaking. The molten wire through which a current was passing, could then be attracted by a magnet.

On behalf of Mr. Carl Zeiss, new portable binocular field-glasses and stereo-telescopes were exhibited. The objects of the new types are (1) to obtain a considerably larger field than that possessed by a Galilean telescope of similar magnifying power: (2) to enhance the stereoscopic effect of the images formed, by placing the object-glasses further apart than the eye-pieces. These objects were attained by prisms and astronomical oculars. The rays passing from the object-glass to the eyepiece undergo four reflections at the surfaces of the prisms, and emerge from the last prism with undiminished intensity. The interposition of the prisms serves to erect the inverted image formed by the object-glass, and, at the same time, to displace the axis of the eyepiece with respect to that of the object-glass, the amount of this displacement being variable within wide limits.

Mr. F. E. Ives had on view his stereoscopic photo-chromoscope. The photo-chromoscope camera makes, at a single exposure on a commercial photographic sensitive plate, three pairs of images, which by differences in their light and shade constitute a record of everything that excites vision in the two eyes. The stereoscopic photo-chromoscope translates this record to the eyes, so that the object photographed appears to be seen through it.

The composite archer's bow, its structure and affinities, was the subject of an exhibit by Mr. Henry Balfour. Archers' bows of composite construction, of wood or horn, or both, overlaid with a "backing" or reinforcement of animal sinews, were shown. There were complete bows from North-west America, Japan, Corea, Manchuria, China, North India, &c., a composite cross-bow from Germany, and an unique specimen of composite bow from a tomb of the twenty-sixth dynasty, Thebes, Egypt. A map and diagram showing the distribution and affinities of the various types of composite bows were also exhibited.

A bifilar pendulum in action was exhibited by the Cambridge Scientific Instrument Company. This instrument was designed by Mr. Horace Darwin for observing and recording slow tilts and pulsations of the earth's crust, by whatever cause they may be produced, and is a modification of that used by the Messrs. Darwin in 1881, at the suggestion of Lord Kelvin. It is possible to observe with this pendulum a tilt of less than $\frac{1}{350}$ of a second, an angle less than that subtended by a line an inch long placed at a distance of a thousand miles, as was shown by the experiments made at Birmingham by Dr. Charles Davison.

The results of experiments on steel gas cylinders were shown by the Gas Cylinder Committee, lately nominated at the request of the Home Office. These showed (1) the danger of using hard or unannealed steel for gas cylinders; (2) the extraordinary amount of violent ill-treatment to which a good soft annealed cylinder may be subjected without destruction, even when charged to 120 atmospheres; (3) the effect of very great internal pressure steadily applied, in this case due to the expansion of liquefied ammonia gas which completely filled the cylinder when cold; (4) the violently destructive character of the explosion of mixed gases under pressure which no practicable cylinder can withstand.

Portable apparatus for gas-testing in electric culverts was shown by Prof. Clowes. A standard hydrogen flame, fed from a small steel cylinder of the compressed gas, is enclosed in a brass vessel provided with a transparent front. This apparatus is mounted on a camera tripod, and is observed by throwing a black cloth over the head. The air to be tested for inflammable gas is pumped over the flame by dropping the end of a flexible tube into the culvert, and compressing a rubber ball provided with suitable valves. A constant stream of the air is thus caused to pass over the hydrogen flame, and by the appearance and dimensions of the flame-cap produced, gas is detected and its percentage is accurately measured. The hydrogen flame can be adjusted to two standard heights, and thus percentages of gas from 0·2 to 5 can be detected and measured.

Geometric wall brackets were exhibited by the Rev. F. J. Smith, F.R.S., and Prof. C. V. Boys, F.R.S. The brackets have been designed with the object of providing wall supports with definite position for physical apparatus. After the apparatus and bracket have been adjusted, they may be removed, and at any time immediately restored to their original position. This is found to be convenient where a class or lecture room is used for some portion of a day only for physical demonstration. The construction is as follows:—Three small projections, A, B, C, are fixed to the wall, one of the two upper projections is furnished with a three-sided indentation, the other with a V-groove, the third is a flat surface; two hemispherically ended screws drop into the upper projections, and the third screw at the bottom of the bracket rests against the flat surface.

Geometric steady blocks were also exhibited. These have been designed so as to rest each on the one below it, upon six independent small surfaces, so as to be geometrically clamped. Thus any number of blocks may be piled to the desired height, and carry physical apparatus with perfect steadiness. Both square and triangular forms were shown.

M. Maurice d'Ocagne, Professor at the École des Ponts et Chaussées, exhibited a very complete series of "abaques" of his invention, intended to perform certain calculations, such as the solution of a cubic equation, or of Kepler's equation, and generally of any equation involving three or four variables. The interest was purely mathematical, appealing to a select few; but the applications of the principle are numerous and important.

Mr. W. Barlow exhibited models to show the nature of the repetition in space which characterises a homogeneous structure having cubic symmetry.

Specimens of ancient "astrolabes" and other instruments were exhibited by Mr. Lewis Evans.

Messrs. Read, Campbell, and Co. showed "aerators" for aerating water and other liquids. The aerator is used in combination with a soda-water bottle and patent stopper. It is made of sheet steel, and contains compressed carbonic acid gas; the soda-water bottle being filled with water or other liquid, the aerator is inserted in the stopper, and the closing of the latter liberates the gas, producing strongly aerated water or other liquid. The aerators may be charged with other gases and used for other purposes than aerating liquids.

There were exhibited by the Meteorological Council: (1) Current charts of the Indian Ocean for the months of January, April, July, and October. The currents shown on these charts had been generalised from a very large number of observations, the arrows and figures attached to them indicating the direction and maximum and minimum velocities of the current likely to be experienced at any particular spot. (2) Wind charts of the South Indian Ocean, between the Cape of Good Hope and New Zealand, for the months of January, April, July, and October.

These charts showed, by a new form of wind rose, recently adopted by the Meteorological Council, not only the frequency of the winds, but their strength, over areas contained by 3° of latitude and 10° of longitude. Isobars were also drawn on the charts so that the relation of the winds to the barometrical pressure could be compared. In the corners of the wind areas the percentage of fog and the number of weather observations were given. A small inset chart showed the temperature of the air, which was represented by isothermal lines, and the limits of fog were also indicated. (3) Sea surface temperature charts of the South Indian Ocean, between the Cape of Good Hope and New Zealand, for each month of the year.

Coming now to natural science, Dr. Woodward, F.R.S., showed a part of the collections made by Dr. C. I. Forsyth Major in Madagascar, 1894–95; and Dr. J. W. Gregory exhibited a geological map of part of British East Africa, with sketches, sections and specimens. The map showed the main features in the structure of British East Africa. The region consists of a plateau of Archean rocks (gneiss and schist) sinking beneath strips of Carboniferous and Jurassic deposits in the coastlands, and buried by piles and sheets of volcanic rocks in the interior. Volcanic activity probably lasted from the Cretaceous to the present day. The lavas have been ejected by plateau eruptions and by crater eruptions. The former poured forth sheets first of trachytoid phonolite, and then of basalt. The country is traversed by the Rift Valley, on the floor of which are thick series of lacustrine deposits; on its walls are the terraces of extinct lakes. Dr. Gregory also showed specimens of Hemiptera (*Flata nigricincta*, Walk.), the colonies of which resemble inflorescences. Mr. H. W. Seton Karr, and Sir John Evans, K.C.B., Treas.R.S., exhibited (1) palæolithic implements from Somaliland; (2) palæolithic implements from Somaliland, ogether with European, Asiatic, and African specimens for comparison.

Gold nuggets showing internal crystalline structure, formed an exhibit by Prof. Liversidge, F.R.S. The specimens (Australian) had been sliced and polished, and then etched with chlorine water or other reagents, so as to show the internal crystalline structure and the presence of enclosures of quartz, iron oxide, &c.

Prof. McKenny Hughes, F.R.S., exhibited (1) specimens illustrating the amount and mode of shrinkage of bog oak; (2) mulberry, showing symmetry in the twigs and asymmetry in the leaves; (3) travertine lining a wooden pipe, and reproducing all the details of the surface on which it was thrown down.

Photographs of "cup and ring" markings naturally formed upon stucco, were exhibited by Mr. C. Carus-Wilson. The wall of a house, built about forty years ago, was covered with stucco. Alternations of temperature, to which the face of the wall had been subjected, had rearranged the particles composing the stucco, producing linear and annular ridges and depressions similar to those occasionally seen on rock-faces, and usually ascribed to the hand of prehistoric man.

Prof. Ray Lankester, F.R.S., showed a cast of enlarged model (eight times natural size) of the type specimen of *Amphitherium prevostii* (lower jaw, Stonesfield slate). Casts taken direct from these very small jaws are of little use. Drawings necessarily fail to show clearly the modelling of the teeth. Accordingly Prof. Lankester has obtained, through the skill of Mr. Pycraft (one of his assistants in the Department of Comparative Anatomy, Oxford), a careful wax model of each of the unique Oxford mammalian fossil jaws, eight times the natural size. A coloured cast of the wax model of one of these jaws, the type specimen of Amphitherium, was exhibited, and similar casts will be offered to the chief European and American museums.

The Marine Biological Association had on view a series of specimens illustrating the boring habits of certain marine animals, amongst them being a series of shells showing the gradual disintegration due to the action of boring sponges. Some rare or interesting marine organisms recently found at Plymouth were also shown by the Association.

Mr. Walter Garstang demonstrated certain adaptations, subservient to respiration, in sand-burrowing Annelids and Crustacea. In aquatic animals which burrow in fine sand, the activity of the gills would be impaired by the accumulation of sand around the gills, or in the course of the respiratory currents. To prevent this, the water before passing to the gills is sieved in the Annelid *Aphrodite* by a felted mass of fine hairs, and in Decapod Crustacea by the hairs bordering the branchiostegite. In the crabs *Atelecyclus* and *Corystes* the normal respiratory current is reversed, and the water passes to the gills through a sieve-tube formed by the interlocking of rows of special hairs on the apposed antennæ. In *Atelecyclus*, which burrows to a shallow depth, the reversal of the current takes place only when the crab is imbedded; in *Corystes*, which burrows deeply, the antennal tube is elongated, and the reversal of the current is all but constant.

A wax model of a single electrical nerve cell from the spinal cord of *Malapterurus electricus* (River Senegal), and microscopic serial sections, was exhibited by Dr. Gustave Mann. The model was made from camera lucida drawings of a complete series of sections through the cell. It showed one axis cylinder process, and an enormous number of dendritic processes which in many cases are joined by their ends to form loops. The model was 500 times the natural size of the nerve cell.

A selection of the dried plants collected in Tibet by Mr. St. George R. Littledale, was exhibited by the Director, Royal Gardens, Kew. The plants were collected in the Gooring Valley, between Tengri Noor and Lhassa, in lat. 30° 12′ N., and long. 90° 25′ E., at an altitude of about 16,500 feet; they represented the general character of the vegetation.

Nuclear division in the spores of *Fegatella conica* was shown by Prof. J. B. Farmer. The spindle in these spores is of a very unusual form at first, but becomes normal subsequently. The primary cell wall remains free in the cytoplasm, and during the two second divisions of the nuclei it becomes rotated through an angle of 90°, and the spore is thus divided into four cells. The ultimate position taken up by the walls corresponds with that of a system of soap films, introduced into a box similar in shape to that of the Fegatella spore, when the cavity of the box is to become divided into four chambers by such films.

Mr. A. Francis Dixon showed a model to illustrate the method of reconstruction from serial microscopical sections by the use of glass plates. This exhibit illustrated a method of reconstruction which is especially useful in tracing the crossing and branching of fine structures, such as nerves and vessels in the embryo. The model was composed of a number of glass plates covered with a transparent varnish. On each plate was traced the outline of a portion of a section belonging to a series, multiplied in the case shown fifty diameters. The thickness of each glass plate was fifty times that of the section drawn on it. When the different plates were placed one over the other in order, a transparent model of the whole structure results, multiplied fifty times. The model shown illustrated parts of the distribution of the trifacial nerve in a rat embryo of the fifteenth day.

During the evening two lectures, with demonstrations by means of the electric lantern, took place. At one of these Prof. Meldola described the exhibits, by M. le Prof. Lippmann, of colour photographs by the interferential method. The photographs, which were projected upon a screen, represented stained glass windows, landscapes and flowers taken from nature, vases, and a portrait from life.

Experiments with liquid air were described by Prof. Dewar, F.R.S., at the second of the two demonstrations.

THE IRON AND STEEL INSTITUTE.

THE annual general meeting of the Iron and Steel Institute was held last week in London, commencing on Thursday, the 7th inst., and continuing over the following day. From the Report of the Council it would appear that the Institute is in a flourishing state. The membership is increasing, and naturally with it the income, whilst the expenditure shows a very remarkable diminution during the last two years. Those who are acquainted with this society know that this lessening cost of management has not been accompanied by any diminution of efficiency.

On the members assembling on Thursday morning, Sir Lowthian Bell occupied the chair in the absence of the President, Sir David Dale, who was prevented from being present by indisposition. The first business of the meeting was the presentation of the Bessemer medal, which had been awarded to Dr. Hermann Wedding, Professor at the Berlin School of Mines, in recognition of the services he has rendered to the iron and steel industries by his valuable contributions to metallurgical literature. An interesting feature in this ceremony was the presence of Sir Henry Bessemer, the venerable founder of the modern steel industry, who made a speech congratulating Dr. Wedding on being selected by the Council as the recipient of the medal.

The following list of papers to be read and discussed was on the agenda.

"On the Rate of Diffusion of Carbon in Iron," by Prof. W. C. Roberts-Austen, C.B., F.R.S.

"On some Alloys with Iron Carbides," by J. S. de Benneville, of Philadelphia.

"On Mond Gas as applied to Steel Making," by John H. Darby, of Brymbo, North Wales.

"On Hot Blast Stoves," by B. J. Hall, of Westminster.

"On the Hardening of Steel," by H. M. Howe, of Boston, U.S.

"On the Introduction of Standard Methods of Analysis," by Baron Hans Jüptner von Jonstorff, of Neuberg, Austria.

"On the Production of Metallic Bars of any Section by Extrusion," by Perry F. Nursey, London.

"On Mr. Howe's Researches on the Hardening of Steel," by F. Osmond, of Paris.

"On the Treatment of Magnetic Iron Sand," by E. Metcalf Smith, of New Zealand.

"On the Making of the Middle Lias Ironstone of the Midlands," by E. A. Walford, Banbury.

Mr. Hall's paper was first taken. It described a form of hot blast stove which has now been in use many years, the first, we believe, having been erected about twelve years ago. It is known as the Ford and Moncure stove, and is of fire-brick, having the ordinary chequer work, although the arrangement varies somewhat from the Cowper or Whitwell patterns, the chief difference being that the stove is divided by walls into four parts. The object is to give facilities for clearing from dust. When the change is made from gas to air the whole of the blast is passed through one of the four divisions, naturally in a very concentrated form. This blows the dust out of the chimney-top, or deposits it in the flues, from whence it can be removed at convenient times. Details given by the author showed that the stoves have a long life, a fact which is perhaps as much due to the excellent proportion on which they are designed as to any special novelty in the construction. From what was said during the discussion, it would appear that the dust-removing device answers satisfactorily.

The next paper taken was Mr. Nursey's contribution, which described a very interesting departure in the production of metal bars of various sections.

The author stated that the system of manufacture was the invention of Mr. Alexander Dick, the inventor of Delta metal. It related to the production of all kinds of metallic sections, from thin wire or plain bars to complex designs, by simply forcing metal, heated to plasticity, through a die by hydraulic pressure. He referred to the fact that although the principle of extrusion was employed in the manufacture of lead pipe and lead wire, yet the temperature was very much lower than in Mr. Dick's system, which required the metal to be red-hot, or about 1000° F. The process consisted in placing the red-hot metal in a cylindrical pressure chamber, or container, at one end of which is a die. Upon pressure being applied at the opposite end the plastic metal is forced through the die, issuing therefrom in the form of rods or bars of the required section and length. The container of the first apparatus made was a solid steel cylinder, bored out to the required diameter to form the chamber for the hot metal, and heated in a coke fire. In practice, however, it was found that the strain set up by the unequal expansion and contraction of the walls of the cylinder, added to that caused by the internal pressure applied to force the metal through the die, developed cracks in the cylinder which rendered it useless. After a long series of experiments with various kinds of steel cylinders, Mr. Dick abandoned the solid wall principle and devised a built-up container. It is composed of a series of steel tubes of different diameters, placed one outside the other, with annular spaces between them, these spaces being filled with a dense non-conducting packing. This device proved perfectly successful, and machines on this principle are now in operation on a commercial scale at the works of the Delta Metal Co., in Germany, and at one of the large Midland metal rolling mills. These machines are served by two men and one boy, so that the cost of labour per ton is very small. The author described the working of the system, and referred to the great variety of sections, some of a very complex nature, produced in Delta metal, brass, aluminium, aluminium bronze, and other alloys and metals, samples of which were exhibited on the table of the theatre. They ranged from wire weighing about 1/100 of a pound per foot run, to heavy rounds, squares, and hexagons weighing 40 lb. and over per foot run. Among the examples was a complex moulding that could not possibly have been made by rolling in the usual way followed for making metal articles of this nature. Mr. Nursey pointed out that the pressure put upon the metal greatly increased its strength, and at the same time rendered it still more homogeneous. Some tests made at Woolwich Arsenal with Delta metal bars produced by extrusion showed a tensile strength of 48 tons per square inch with 32·5 per cent. elongation on 2 inches, as against 38 tons per square inch tensile strength and 20 per cent. elongation of rolled bars of the same metal. The author concluded by stating that Mr. Dick was engaged on experiments with the view of producing sections in iron and steel similar to those at present turned out in Delta metal.

In the discussion which followed the reading of Mr Nursey's paper, Mr. Snelus described a process of covering telephone cable with lead, somewhat analogous to that referred to by the author. This cable contained over 150 wires, and was three inches in diameter. The fluid lead was pressed over it through dies. The great difficulty in all processes of formation by extrusion is to get a material for making the dies which will stand the hard usage to which they are put. Mr. Dick uses tungsten steel, a very hard material which does not require tempering; this, it seems, is good enough for Delta metal, one of the many new bronzes, and for the other materials mentioned. But if it were necessary to deal with metals having a higher melting point, a still more refractory metal would be required, and one of equal hardness, as the dies must not only withstand heat, but erosion. Mr. Snelus was of opinion that if the container, or cylinder, used for forcing out the fluid metal, were made of some highly refractory earth, that steel pipes could be made in this way. That, of course, would be a great commercial success, for not only could the pipes be cheaply manufactured in long lengths, but the quality would doubtless be much improved. In the present day of water-tube boilers this is a matter well worth considering. The difficulty in making steel tubes, however, does not appear to rest with the production of a refractory container. Mr. Dick said that he had made steel bars by extrusion, although it was done accidentally, and the trouble was, not that the cylinder gave way, but that the dies would not stand the work; if, therefore, an ingenious metallurgist can discover an alloy as hard as tungsten steel, and more refractory, he will possibly make a considerable fortune.

Mr. Metcalf Smith's paper was next taken. The author described the method adopted in New Zealand of smelting, or perhaps one should say melting, the iron sand found so largely in that country. The paper stated that the sea cliffs on this part of the coast consist of a combination of silica sand and a rich magnetic iron sand; the gradual crumbling of these cliffs, together with large quantities of iron sand brought down by the rivers and streams, draining the slopes of Mount Egmont, result in a deposit of almost pure iron sand on the beach, a large proportion of the lighter silica sand being washed out to sea. Excavations have been made on the beach showing a depth of iron sand of fourteen feet, whilst the same material has been dredged up at a distance of three miles out to sea. Nature seems to have devised this district most fitly for an iron industry; for not only are these vast deposits of magnetic iron so easily obtainable, but in close proximity there are extensive coal beds. There is also limestone containing 88 per cent. of calcium carbonate, timber for charcoal if required, and, indeed, provision for supplying all the needs of iron manufacture. Here is an analysis of the iron sand, made by Sir James Hector:

Peroxide of iron } Protoxide of iron }	82·0
Oxide of titanium	8·0
Silica	8·0
Water and loss	2·0
	100·0

Of course iron sand is known in other countries besides New Zealand, and efforts have often been made to smelt it. The difficulty, however, has been that it comes down and chokes the furnace when melting begins, so that it descends to the hearth unreduced. This is got over in New Zealand by kneading it into bricks with clay, which is found close by. In this way hard and compact lumps are procured, which will stand the pressure and grinding action in travelling through the furnace. One ton 12 cwt. of iron sand is mixed with 10 cwt. of clay; and in this

way, what is equivalent to a very rich ore is produced. The pig iron made gives an excellent analysis. It is not, however, necessary to smelt all the iron sand in this way, for a certain part of it can be mixed with fluid iron, tar being added. The liquid metal will melt and absorb the iron sand, the tar giving sufficient carbon to retain the metallic iron in a fluid state. There is, of course, a saving in cost in this method of procedure, and the metal may be run direct for castings, thus avoiding the loss in remelting. Bar iron is made by puddling from tarred iron sand and smelted metal. In the Siemens furnace, also, the same method of procedure is followed. Figures are given in the paper as to the cost of these processes, but the most remarkable details are those referring to the quality of the product. Thus we are told that by the treatment described, bar iron, equal in quality to BBH, can be produced for £7 per ton, and wrought iron, which will give what the author truly described as "the extraordinary tensile stress of 52 tons to the square inch." One would be inclined to describe this tenacity in wrought iron, not only as extraordinary, but as almost incredible; at any rate, one would wish to see the test authenticated by at least more than one experimenter of high reputation before accepting it as unquestionable. This would be more especially the case if, as we understood the author to say, the elongation was $33\frac{1}{2}$ per cent.

Mr. Walford's paper was next taken. Its object was to describe the character of the Middle Lias ironstone of the Midlands and its organic origin, and the making of the stone and its ferruginous changes.

At the conclusion of the reading of this paper the meeting adjourned until the next day.

On the members again assembling on Friday morning the paper of Baron Jüptner was the first taken, being read by Mr. H. Bennett Brough in the absence of the author. This was a very long contribution consisting of thirty-six pages, but, as was said during the discussion which followed its reading, it was not a word too long. The subject is one of great importance, and has been far too long neglected. The want of uniformity in analysis has led to much confusion and consequent loss of money in the iron and steel industries. In a general description of the meeting, such as this, it would be impossible to do justice to a subject of this magnitude, and at present we can only make brief reference to the proposals contained in the paper, hoping to return to the question so as to deal with it at greater length on a future occasion. A large part of the paper was occupied in giving examples of discrepancies in analyses; thus, in an instance quoted, a chill roll was examined in two laboratories, and quite incredible differences were obtained. In one case the carbon was returned as 3·5 per cent., in another 2·785 per cent. Silicon in the first analysis was given at 1·3 per cent., the second laboratory gave 0·668 per cent. Other instances almost as striking were quoted by the author. What is proposed now to be done is to establish an international laboratory in Switzerland. All the important nations are to nominate honorary directors of work. For the purposes of making analyses, however, paid investigators will be necessary. Dr. Wedding, who spoke during the discussion, said that it was estimated the cost would be about £3000 a year, and he thought that if 300 of the principal iron and steel works in the world would contribute yearly £10 apiece, the work for a period of ten years could be done. Sir Lowthian Bell was of opinion that there should be no difficulty in getting this amount of money, and promised that his own works should contribute. It is perhaps unnecessary to point out that English iron and steel works are in some cases—there are, of course, notable exceptions—lamentably deficient in the scientific department. Mr. Stead, whose experience is very wide, and who speaks as a disinterested observer, said that in some establishments of considerable importance the chemist only received a salary of £100 a year. How can a man be expected, not only to work with that enthusiasm with which all scientific men must work for their labours to be effective, but to keep abreast of knowledge by the purchase of books, and subscriptions to technical or scientific societies, on such a stipend as this, which can allow no surplus after the barest necessities of life have been supplied? Mr. Stead pointed out that technical libraries were not common enough in this country, and he would suggest that in all large manufacturing centres libraries of that nature should be instituted. This, however, would not quite meet the difficulty. Abroad, especially in Germany, one finds iron and steel works have libraries of their own, the collection of books they possess being sufficiently large in most cases to be dignified by the name. Unfortunately in England, beyond a few elementary treatises or text-books, very little literature is seen in the laboratories, the chemist too often contenting himself with following well-known and stereotyped methods of analysis, and not troubling himself with any original work which might lead to fresh industrial developments. A good deal has been heard lately about German competition in the iron and steel trade, and there has been an inclination to attribute it to higher wages paid in this country. It may be, however, that there is something to be said not only against labour, but against capital in this matter; and certainly German steel makers have gone ahead of those in England in many cases. We have in mind, perhaps just now more especially, the development of the basic steel industry, the invention of which originated in this country. By the exercise of greater foresight, greater enterprise, and improvement in processes, Germany has gained a commercial advantage from which England is now suffering. In the discussion that followed the reading of the paper, one or two suggestions were made which should be put on record. Prof. Arnold drew attention to the effect of segregation, of which he has met with some striking examples of late. In a tyre examined, sulphur was in one case 1 per cent.; in another sample, taken an inch and a half from the first, the sulphur was ·043. Mr. R. A. Hadfield said that allowance should be made for previous treatment of metal, and, in considering the history of a sample, its size, previous mechanical treatment, and from what part of the ingot it was taken, should be noted. Dr. Readel was of opinion that the iron and steel industry was behind other industries in devising standard methods of analyses. The British Association Commission, he said, did good work, but there was the defect of want of organisation. Each member went on his own line, so that the same ground was covered more than once. An orderly scheme of procedure was the first thing necessary, certain work being allotted to different individuals; he had had, recently, occasion to look into the subject of chromium, and had found even for this metal some thirty or forty processes for determining its presence. What was necessary was that some one with authority should make a selection showing that which might be the most desirable to retain. Mr. Ainsworth made a suggestion which it is to be hoped will not be lost sight of. The accumulated funds of the Institute are about eight or nine thousand pounds, and with the improved management of the present day, the sum is likely to be increased at a rapid rate. Mr. Ainsworth pointed out that it is not desirable to hoard this money, and no better means could be devised for spending it than bringing out of the present chaos an orderly method of chemical analysis. The suggestion was warmly supported by the Chairman, Sir Lowthian Bell.

It may be said that chemical analysis has fallen somewhat into disfavour with iron and steel makers of late, and also with engineers, the tendency being to trust wholly to physical experiment, aided latterly by microscopical examination. It is certain, however, that nothing can take the place of chemistry in metallurgical research; and the disfavour with which it is now regarded is not the result of faults inherent to the system of chemical examination, but to the imperfect manner in which it is carried out.

Mr. Darby's paper was taken next. It described a process which promises to be of great importance in the iron and steel trade, by means of which sulphate of ammonia is obtained from producer gas without the gas being rendered unfit for steel making. For many years steel makers have had such a process in view, and experiments have been made with a view to bring it to practical shape. So far as we are aware, however, they have all hitherto resulted in failure, or, at any rate, have not been a commercial success. Mr. Darby's experiments, however, go to show that Dr. Mond has solved the problem. We have not space to enter into details here, but must refer our readers to the very interesting paper which will be published in the *Transactions*, and in which the method of working the apparatus is shown by a diagram. Although the experiments of Mr. Darby were carried out on a practical scale, the furnace was a small one; but this was rather against the process, as it is more difficult to work a small steel furnace, and keep the metal fluid, than a large one. The plant required for carrying out the process is undoubtedly very costly, but as the return in ammonia will enable a dividend of 25 per cent. to be paid on the outlay, there doubtless will be little difficulty in finding the money in large steel works. It is to be hoped that the English steel makers will not neglect to inquire into and consider this oppor-

tunity of adding to their returns, and will not once more allow the foreigner to develop a system originally devised in this country.

In the discussion on the paper, several steel makers, who had seen Mr. Darby's plant in operation, spoke as to the excellent way in which the furnace worked when using gas which had been treated for the extraction of the ammonia.

Prof. Roberts-Austen next gave a brief address on the diffusion of carbon in iron, he not having prepared a paper in the usual way. The subject has recently been described by the same author in the Bakerian Lecture of the Royal Society and will shortly be treated in these columns; it is therefore unnecessary for us to go into the matter on the present occasion.

The remainder of the sitting was almost wholly occupied by the reading and discussion of M. Osmond's and Mr. Howe's papers, the paper of M. de Benneville being taken as read. It would be impossible at the end of a report of this nature to deal with the highly controversial matters which form the subject of these two papers; and indeed, without the introduction of the micro-sections supplied by Mr. Howe, the matter would not be intelligible. The allotropic theory of the hardening of steel, which has already caused so much discussion, did not appear to be carried very much further on Thursday last, or, at any rate, the majority of those present at the meeting did not seem to see their way much further towards the end of the problem. M. Osmond welcomes Mr. Howe as a friend and ally. He looks on the latter's carbo-allotropic theory as not antagonistic to his own. The discussion was confined principally to Prof. Arnold and Mr. Hadfield, who are the chief opponents of the school represented principally by M. Osmond and Prof. Roberts-Austen, now, we suppose, with Mr. Howe as an ally.

The summer meeting of the Institute is this year of an unusually ambitious nature, and will be held in September in Bilbao, a steamer having been chartered for the conveyance of members to that port. The vessel is the Orient liner *Ormuz*, which will also serve as a floating hotel for members during the meeting.

A REMARKABLE DUST-STORM.

THE American journal *Electricity* for February 19 contains an account of an unusual kind of storm which occurred in January of this year. The details were communicated by L. H. Korty, telegraph superintendent of the Union Pacific System, of Omaha, Neb. It was on the telegraph lines of this system between Weber and Peterson, Utah, that considerable difficulty was experienced in working, owing, as it is stated, to the peculiar character of the storm in question. The description is as follows:—

"On the afternoon of January 16, a very peculiar rain-storm occurred in Eastern Utah and Western Wyoming, along the Union Pacific Railway, extending from Ogden, Utah, to Evanston, Wyoming, a distance of 75 miles. The rain consisted of salt water or brine. The clothing of persons exposed to the shower had, when dry, the appearance of having been sprinkled with whitewash. The windows in the stores and residences at Evanston were so encrusted with salt deposit as to make it impossible to look out. Dr. C. T. Gamble, of Almy, Wyo., a gentleman of undoubted trustworthiness, states that the storm deposited in Almy alone 27 tons of salt. 'This assertion may appear fabulous,' says the doctor, 'but nevertheless is true, as it has been proved by carefully estimating the quantity on a given surface in different parts of the camp. The area of Almy is something over nine miles, and three tons to the mile would make 27 tons of the sodium deposited. The salt if collected and sacked would make ten ordinary wagon-loads. Those who doubt the above statements, go to figuring.'

"The salt-storm lasted about two hours. After it had ceased raining, the sun came out, and as fast as things dried they turned a whitish colour, and it was found that everything was covered with a thick coating of salt. Cars, buildings, trees, telegraph poles, insulators and wires all looked ghastly in their white coats. Through Weber Cañon the salt storm turned into snow later. A peculiar effect of the salt deposit on the telegraph poles, arms and insulators through Weber Cañon was noticed in operating the wires. During the day, when the sun came out, the wires worked clear and without interruption, while at night, when it turned cold, the wires were rendered unserviceable, which was attributed to the fact that the snow, having melted, some during the daytime and again freezing at night, created a moisture in conjunction with the salt deposit underneath, so as to entirely destroy the insulation of the wires. After several unsuccessful attempts to remove the cause of the trouble, an engine with a pump and long hose was sent over the line, and the deposit thoroughly washed off the poles and fixtures for a distance of 40 miles. The wires of the Rio Grande Western Railroad between Ogden and Salt Lake City were slightly affected in the same way, as were also those of the Southern Pacific for a short distance west of Ogden."

It has been suggested, as an explanation of the facts, that the salt was raised in vapour over Great Salt Lake, and was carried by the wind and deposited over the country for many miles to the eastward. This, of course, could not have happened, as *salt could not be raised in vapour*. It seems likely, however, that the white residue may have had the appearance of salt, but was not actually salt. Would not a more reasonable explanation be that fine white dust in the region about the lake may have been carried into the upper regions by the wind, and after traversing some miles brought to earth again owing to the condensation of the vapour surrounding them?

SCIENCE IN THE MAGAZINES.

THIS month's magazines contain numerous articles on scientific topics or with scientific bearings. Röntgen photography naturally forms the theme of several contributions. The *Quarterly Review* contains a short descriptive account of methods employed, results obtained, and theories propounded, and even blossoms into illustrations reproduced from radiographs taken by Mr. A. A. C. Swinton. The *Century Magazine* has "a Symposium on the Röntgen Rays," the writers being T. C. Martin, R. W. Wood, Elihu Thomson, Sylvanus P. Thompson, J. C. McLennan, W. J. Morton, and Thomas A. Edison. The result of this composite article is vain repetition of experimental conditions, and a confusion of tongues; Prof. Thompson referring to pictures obtained by Röntgen rays as "sciographs," while other writers describe them as "shadowgraphs," and all the illustrations are designated "cathodgraphs."

Dr. St. George Mivart writes on "Life from the Lost Atlantis" in the *Fortnightly*, his paper being concerned chiefly in pointing out the significance of the discovery of *Cænolestes obscurus*, a still-existing survivor of Ameghino's Epanorthidæ, and the representative of a new family of recent marsupials, described by Mr. Oldfield Thomas before the Zoological Society on December 17, 1895.

"This little, apparently insignificant, mouse-like creature," to quote the author, "turns out to be an animal of extreme interest, for it affords strong evidence that what we now know as South America and Australia must have been connected, and the Atlantic at least bridged by dry land, if even an Antarctic continent may not have existed, of which South America and Australia are divergent and diverse outgrowths."

Mr. G. E. Boxall puts forward, in the *Contemporary*, the view that the vast sedimentary plains of Australia, which thirty years ago were so "rotten" that no stock could be kept upon them, have been trampled into compactness by large herds of cattle and sheep. He gives reasons for believing the dry plains of Western Australia to be similar to those described by Oxley and others as once existing in the delta of the Murray, where about one hundred millions of sheep are now pastured, besides large herds of cattle and horses; and therefore he thinks that the present sandy plains will sooner or later be consolidated and rendered secure for stock. He concludes:

"The plains of Australia are, from the accounts given of them by explorers in all parts of the continent, singularly alike, and if the plains of Northern and Western Australia can be consolidated by the trampling of stock, as I believe those of the eastern districts have been, the time is not far distant when the word 'desert' may be wiped off the map of Australia, and the true character of its vast plains become more generally understood and appreciated."

Psychologists will be interested in a paper by Mr. Havelock Ellis, in the same review, on "The Colour-Sense in Literature." Mr. Ellis has examined the works of a series of imaginative writers, usually poets, dating from the dawn of literature to the present time, and has noted the main colour-words that occur, and has also noted how these words are used. His paper

contains the numerical results arrived at, together with certain observations suggested by them. The tables given lend support to the following interpretation :—

"The predominance of green or blue—the colours of vegetation, the sky, and the sea—means that the poet is predominantly a poet of nature. If red and its synonyms are supreme, we may assume an absorbing interest in man and woman, for they are the colours of blood and of love, the two main pivots of human affairs, at all events in poetry. And where there is a predominance of black, white, and, I think I would add, yellow—the colours that are rare in the world, and the colour of golden impossibilities—there we shall find that the poet is singing with, as it were, closed eyes, intent on his own inner vision. . . . Although I cannot claim to have put this numerical test of colour-vision into a final shape, there can be little doubt that it possesses at least two uses in the precise study of literature. It is, first, an instrument for investigating a writer's personal psychology, by defining the nature of his æsthetic colour-vision. When we have ascertained a writer's colour-formula and his colours of predilection, we can tell at a glance, simply and reliably, something about his view of the world which pages of description could only tell us with uncertainty. In the second place, it enables us to take a definite step in the attainment of a scientific æsthetic, by furnishing a means of comparative study. By its help we can trace the colours of the world as mirrored in literature from age to age, from country to country, and in finer shades among the writers of a single group."

Another article in the *Contemporary* is of scientific interest : it is on "The Proposed Gigantic Model of the Earth," by Dr. A. R. Wallace. It may be remembered by our readers that M. Elisée Reclus has drawn up a scheme for constructing a terrestrial globe on a scale of one-hundred-thousandth the actual size, that is, 418 feet in diameter. Another globe would be required as a cover for the actual earth-model, so that the expense of such a duplex structure would be enormous. Dr. Wallace gives a qualified support to M. Reclus' proposal ; for he thinks only one globe should be constructed, showing all the great geographical features of the earth on its outer surface, while on the inner surface would be formed that strictly accurate model which M. Reclus considers would justify the expense of such a great work.

Miss Mary Kingsley contributes to the *National* an interesting account of her ascent of "The Throne of Thunder," or the Peak of Cameroons, the highest point on the western side of the African continent. Twenty-seven white men have reached the peak, and Miss Kingsley describes the twenty-eighth ascent, the second successful one from the south-east face. In the same review Mr. A. G. Boscawen, M.P., gives his impressions of Japan, and concludes his remarks with a few words about British commercial interests in the Far East. It is satisfactory to note his remarks on the advantages to be gained by the appointment of commercial and technical advisers to foreign Legations. He says :—

"And now I would suggest what I have suggested elsewhere, that the Government ought to give a helping hand by appointing a commercial *attaché* to the Legation at Tōkyō, who I feel sure would prove most useful at the present moment, when the Japanese are friendly to us, and are certainly inclined to buy from us if we will only take the trouble to adapt our manufactures to their markets. Such an official, by keeping us constantly informed at home of what articles the Japanese require, would prevent a large portion of our trade from going to foreigners, especially to the Germans and Americans, who have for years taken far more trouble than we have to secure the goodwill of the Japanese."

A passing mention must suffice for the remaining articles of scientific interest in the magazines and reviews received. Sir Robert Ball writes on "The Scenery of the Moon," in the *Strand Magazine*, his description being illustrated by reproductions from lunar photographs. Miss Agnes Giberne treats the well-worn theme of "The Far Distance of our Universe," in *Chambers's Journal*, which also contains popular articles on the electric supply of London, jumping beans, and house-flies. Some suggestive points in connection with the evolution of language will be found in the article entitled "The Genesis of Expression," by M. L. Johnson, in the *Westminster Review*. A well-illustrated paper on "The Evolution of the Trotting Horse," contributed by Mr. Hamilton Bushey to *Scribner*, is not without interest to scientific readers. Under the title "Through Scientific Doubt to Faith," the *Quarterly Review* traces the mental history of Romanes, as evidenced by his own works, and in the lately published "Life and Letters," written and edited by his wife. The article is a complacent statement from the religious side. The Viscount Harberton writes on "Muzzling and the Prevention of Rabies" in the *Humanitarian*. Mr. P. C. Knapp brings forward evidence, in the *Century*, against the view that nervous disorders are increasing, and shows that, without more evidence in its favour, the belief in the greater nervousness of Americans is an error. Finally, the *Geographical Journal* contains Mr. St. George Littledale's account of "A Journey across Tibet, from North to South, and West to Ladak," and Mr. Edward A. FitzGerald's paper on "The First Crossing of the Southern Alps of New Zealand" Attention may profitably be drawn to the maps which illustrate Mr. Littledale's journey, and to a new map of the Upper Kuyuni River, British Guiana, from a recent survey.

THE METRIC SYSTEM IN THE UNITED STATES.

STRENUOUS efforts are being made by the American Metrological Society to secure the adoption of the Bill making the use of the metric system obligatory in the United States after a specified date. Letters have been sent to all who are interested in the question, soliciting their help and influence, and petitions are being numerously signed and sent in to Representatives. The Committee on Coinage, Weights and Measures, of the House, recently reported unanimously in favour of the Bill, and the introduction and conclusion of their interesting report are reprinted in *Science*, from which source the subjoined summary has been made.

For more than a generation after the construction of the constitution, the American people lived with no legal standard by which could be determined even the amount of metal which went into the coin that came from their mints. Gallatin procured from France a platinum kilogram and meter in 1821, and from England a troy pound in 1827, and in 1828 the latter was recognised as the standard for mint purposes by the following Act :

"For the purpose of securing due conformity in weight of the coins of the United States to the provisions of this title, the brass troy pound weight procured by the Minister of the United States at London in the year eighteen hundred and twenty-seven for the use of the mint and now in custody of the mint at Philadelphia, shall be the standard troy pound of the mint of the United States, conformably to which the coinage thereof shall be regulated."

Meantime both the people and the Government were using such weights and measures as were nearest at hand, derived in the main from the English ancestry, but made by themselves without any authoritative standard for comparison, and as a consequence differing materially from each other. In 1830 the Senate directed the Secretary of the Treasury to have a comparison made of the standards of weight and measure used at the principal custom houses of the United States, and report the same to the Senate. This was done, and large discrepancies and errors were found to exist. These discrepancies were nullifying and violating the provision of the Constitution which prescribes that "all duties, imposts and excises shall be uniform throughout the United States." Varying scales and varying measures inevitably produced varying rates of duty. The Treasury Department, therefore, in the exercise of its executive power and as a necessary incident and means to the execution of the law and the observance of the Constitution, adopted for the use of that Department the Troughton scale, then in the possession and use of the Coast Survey, as the unit of length, and the troy pound of the mint as the unit of weight. From the latter the avoirdupois pound was to be derived, assuming that there were 7000 grains in the pound avoirdupois to 5760 in the pound troy. For measures of capacity the wine gallon of 231 cubic inches, and the Winchester bushel of 2150·42 cubic inches, were adopted. This gave to the Treasury Department the basis of a system of weights and measures to be used in its operations, and in order to promote the general adoption and use of the same throughout the country, Congress, in June 1836, adopted the following joint resolution :

"That the Secretary of the Treasury be, and he hereby is,

directed to cause a complete set of all the weights and measures adopted as standards, and now either made or in the progress of manufacture for the use of the several custom houses, and for other purposes, to be delivered to the Governor of each State in the Union, or such persons as he may appoint, for the use of the States, respectively, to the end that a uniform standard of weights and measures may be established throughout the Union."

In accordance with this resolution, sets of the weights and measures adopted for use in the custom houses were sent to the several States, and only in this indirect and inferential way have the customary weights and measures of the United States been legally recognised. By the Act of March 3, 1881, similar sets of standards were directed to be supplied to the various agricultural colleges which had received land grants from the United States at a cost not exceeding 200 dols. for each set. This law was complied with as best it could be under the limitation of cost prescribed.

Meantime the metric system had come into extensive use among other nations, and into almost universal use in the realm of exact science the world over. The Americans touched it at every turn in their commercial relations and scientific investigations. Uniformity in weights and measures throughout the world was urged not only by men of science, but by sagacious business men, seeking to keep pace with the rapidly growing tendencies to closer commercial and business relations among the nations resulting from the improved facilities of communication and transportation which had largely removed the barriers of space and distance. Hence in 1866 Congress, with the approval of the President, placed on the statute books the following law:

"AN ACT to authorise the use of the metric system of weights and measures.

"*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That from and after the passage of this Act it shall be lawful throughout the United States of America to employ the weights and measures of the metric system, and no contract or dealing, or pleading in any court, shall be deemed invalid or liable to objection because the weights or measures expressed or referred to therein are weights or measures of the metric system.

"Sec. 2. *And be it further enacted*, That the tables in the schedule hereto annexed shall be recognised in the construction of contracts, and in all leading proceedings, as establishing, in terms of the weights and measures now in use in the United States, the equivalents of the weights and measures expressed therein in terms of the metric system; and said tables may be lawfully used for computing, determining and expressing, in customary weights and measures, the weights and measures of the metric system."

To make this law of practical use the following joint resolution was adopted:

"JOINT RESOLUTION to enable the Secretary of the Treasury to furnish each State with one set of the standard weights and measures of the metric system.

"*Be it resolved by the Senate and House of Representatives of the United States of America in Congress assembled*, That the Secretary of the Treasury be, and he is hereby authorised and directed to furnish to each State, to be delivered to the Governor thereof, one set of standard weights and measures of the metric system for the use of the State respectively."

By inadvertence, and without important legal significance, the resolutions providing for furnishing the standards became a law before the Act authorising the use of the system. In the same year Congress put it in the power of the Post-Office Department to make extensive use of metric weights in its operations. The law of that year was re-stated and re-enacted in 1872, and now stands in the Revised Statutes in the following terms:

"The Postmaster-General shall furnish to the post-offices exchanging mails with foreign countries, and to such other offices as he may deem expedient, postal balances denominated in grams of the metric system, fifteen grams of which shall be the equivalent for postal purposes, of one-half ounce avoirdupois, and so on in progression."

The International Postal Convention of two years later, and which by subsequent renewals is now in force between the United States and fifty other nations, uses only metric weights and terms, and to-day the mail matter transported between America and other nations, even between the United States and England, is weighed and paid for entirely in terms of metric weights.

Here legislation on the subject of weights and measures rested till 1893. In the meantime important action was taken by the Executive Department of the Government. The progress of science, carrying with it the capability of more accurate observation and measurement, had disclosed the fact that the metric standards in use in different countries differed among themselves, and indicated that even the standards in the archives of France could be constructed with greater precision and accuracy, and preserved with greater safeguards against possible variation from influence of the elements or other forces. Hence France invited the other nations to join in an international Commission for the purpose of constructing a new metre as an international standard of length. America accepted the invitation, and was represented in the Commission, which met in 1870, and continued its labours from time to time till they were finally consummated in the conclusion of a metric convention signed on May 20, 1875, by the representatives of the following nations, viz. the United States, Germany, Austria-Hungary, Belgium, Brazil, Argentine Confederation, Denmark, Spain, France, Italy, Peru, Portugal, Russia, Sweden and Norway, Switzerland, Turkey, and Venezuela.

The first name signed to this convention is that of E. B. Washburn, the United States Minister and Representative. The treaty provided for the establishment and maintenance, at the common expense of the contracting nations, of "a scientific and permanent international bureau of weights and measures, the location of which shall be Paris," to be conducted by "a general conference for weights and measures, to be composed of the delegates of all the contracting governments." Beyond the construction and custody of the international standards and the distribution to the several countries of copies thereof, it was expressly provided as to this conference by the terms of the treaty or convention that "it shall be its duty to discuss and initiate measures necessary for the dissemination and improvement of the metrical system." This convention was duly ratified by the Senate, and since that time the United States has been regularly represented in the International Conference, and has paid its proper proportion of the cost of maintaining the International Bureau of Weights and Measures. By the terms of the convention the privilege of acceding thereto and thus becoming a party to it was reserved to any nations desiring to avail themselves thereof, and accordingly the following nations have since become parties to the convention, viz. Servia in 1879, Roumania in 1882, Great Britain in 1884, Japan in 1885, and Mexico in 1891.

New standards were prepared with extreme care and accuracy, and duplicate copies thereof distributed to the several nations. Those for the United States were received with much ceremony at the White House, January 2, 1890, by the President in the presence of members of his Cabinet and other distinguished gentlemen, and are now carefully guarded in a fire-proof room set apart for the safe-keeping of the standards of weights and measures in the Coast Survey building.

By formal order of the Secretary of the Treasury of April 5, 1893, the metre and kilogram thus received and kept were recognised as "fundamental standards" from which the customary units of the yard and pound should be thereafter derived in accordance with the law of July 28, 1866.

Meantime Congress by Act of March 3, 1893, established a standard scale for measurement of sheet and plate iron and steel, expressed in terms of both the customary and metric measures. "An Act to define and establish the units of electrical measure" was passed by the Fifty-third Congress and approved July 12, 1894. It is based on the metrical system exclusively.

From this *résumé* of United States legislation on the subject of weights and measures it appears that a legal standard of weight has been established for use in the mint, but that beyond that the weights and measures in ordinary use rest on custom only with indirect legislative recognition; that the metric weights and measures are made legal by direct legislative permission, and that standards of both systems have been equally furnished by the Government to the several States; that the customary system has been adopted by the Treasury Department for use in the custom houses, but that the same Department by formal order has adopted the metric standards as the "fundamental standards" from which the measures of the customary system shall be derived. This presents a condition of legal complication and practical confusion that ought not to continue. The constitutional power vested in Congress should be exercised.

The Committee confessed that considerable temporary inconvenience would probably accompany the change, but they

believed that this was greatly over-estimated, and that it would be of short duration. But whether the inconvenience be little or great, it must some time be encountered, and it will not be decreased by the increase of the population. It will be no easier for a hundred millions of people ten years hence to make the change than for seventy millions to-day. It is simply a question whether this generation shall accept the annoyance and inconvenience of the change largely for the benefit of the next, or shall the people of to-day selfishly consult only their own ease and impose on their children the double burden of learning and then discarding the present "brain-wasting system." The present generation must meet this test of selfishness or unselfishness, and answer to posterity for duty performed or neglected.

The Committee, after a careful consideration of the whole subject, unanimously reached the conclusion that the metric system of weights and measures should be put into exclusive use in the various Departments of the Government at such future date as shall allow adequate preparation for the change, and at the end of a fixed time thereafter that said system shall be recognised as the only legal system for general use. They, however, do not deem it wise at present to require a change in the methods of surveying the public lands, as this would in that respect destroy rather than promote uniformity.

The Committee deemed it prudent to enlarge the time for the proposed system to take effect to a date somewhat later than the date proposed in the Bill submitted, adopting for America about the average time deemed necessary by other nations. It is therefore recommended that the time for adoption in the Departments and operations of the Government, except in the completion of the survey of the public lands, be fixed for July 1, 1898, and that the adoption of the metric system for use in the nation at large be fixed as coincident with the dawn of the twentieth century, and that date be accordingly changed to January 1, 1901, the first day of the new century.

The Bill reads as follows:—

"A Bill to fix the standard of weights and measures by the adoption of the metric system of weights and measures.

"*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That from and after the first day of July, eighteen hundred and ninety-eight, all the Departments of the Government of the United States, in transaction of all business requiring the use of weight and measurement, except in completing the survey of the public lands, shall employ and use only the weights and measures of the metric system.

"Sec. 2. That from and after the first day of January, nineteen hundred and one, the metric system of weights and measures shall be the only legal system of weights and measures recognised in the United States.

"Sec. 3. That the metric system of weights and measures herein referred to is that in which the ultimate standard of mass or weight is the international kilogram of the International Bureau of Weights and Measures, established in accordance with the convention of May twentieth, eighteen hundred and seventy-five, and the ultimate standard of length is the international metre of the same bureau, the national prototypes of which are kilogram numbered twenty and metre numbered twenty-seven, preserved in the archives of the office of standard weights and measures.

"Sec. 4. That the tables in the schedules annexed to the Bill authorising the use of the metric system of weights and measures passed July twenty-eighth, eighteen hundred and sixty-six, shall be the tables of equivalents which may be lawfully used for computing, determining and expressing the customary weights and measures in the weights and measures of the metric system."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The first Smith's Prize is awarded to Mr. W. S. Adie, bracketed Senior Wrangler 1894; the second is divided between Mr. A. Y. G. Campbell, bracketed ninth Wrangler, and Mr. F. W. Lawrence, bracketed fourth Wrangler in the same year. All the prizemen are members of Trinity College.

Prof. Newton, F.R.S., has been reappointed one of the managers of the Balfour Studentships in Animal Morphology until June 1901.

The School of Medicine of the University of Toronto has been placed on the list of Colonial Schools recognised by the Special Board for Medicine.

The Council of the Senate recommend for affiliation to the University the Roman Catholic College of St. Edmund's, Ware, the successor since 1793 of the former English College at Douai.

On account of the increasing length of the practical examinations for the Natural Sciences Tripos, the Medical Board propose that the examinations for M.B. shall in future take place at a later date in the Michaelmas and Easter Terms. It is noted that a number of medical students are following with advantage the course for the ordinary B.A. degree, and a rearrangement of the dates of the examinations has become necessary to meet their case.

The next examination for the diploma in Agriculture will begin on July 6, and last a week.

SIR WILLIAM PRIESTLEY, the distinguished physician, has been elected parliamentary representative of the Universities of Edinburgh and St. Andrews.

THE City and Guilds of London Institute is inviting applications for the Professorship of Mechanical Engineering and Applied Mathematics at the Technical College, Finsbury, rendered vacant by the appointment of Prof. John Perry, F.R.S., to a Professorship at the Royal College of Science. Applications for the appointment should be addressed to the Honorary Secretary at the office of the Institute, Gresham College, E.C.

THE following are among recent appointments:—Dr. Zuber, Privatdocent in Geology in Lemberg University, to be Extraordinary Professor; Dr. Henking, Privatdocent in Zoology in Göttingen University, to be Extraordinary Professor; Dr. Oertel to be Observer in the Observatory at Munich; Dr. Ludwig Kathariner to be Professor of Zoology and Comparative Anatomy in the University of Fribourg; Prof. Dr. Buchner to be Extraordinary Professor of Chemistry at Tübingen; Dr. Albert Fleischmann to be Director of the Zoological Institute at Erlangen; Dr. George Rorig to be Extraordinary Professor of Zoology in Konigsberg University.

MR. JAMES G. LAWN, Instructor in Mine Surveying at the Royal College of Science, London, has been appointed Professor of Mining at the South African School of Mines. The School was started some years ago, but it is undergoing reorganisation. It is proposed that the course of instruction shall extend over four years; the first two years—in which scientific instruction will be given—being spent at the South African College, Cape Town. The third year will be spent at Kimberley, where theoretical and practical instruction in mining will be given. The fourth year will be chiefly taken up with practical work at Johannesburg. The Cape of Good Hope University is to be asked to establish a Mining degree, the final examinations for which the students would attend at the end of their fourth year. So far only the preliminary scientific instruction has been given, and Mr. Lawn is going out to organise and initiate the instruction to be given in the third and fourth years of the course. The salary is £800 a year.

FULL recognition is being given to the scientific attainments of women in America. We learn from *Science* that at Bryn Mawr College Miss F. Cook has been appointed Fellow in mathematics; Miss F. Lowwater, in physics, and Miss C. Fairbanks, in chemistry.

Science records the following gifts to education and research in America. Mrs. Lydia Bradley, of Peoria, Ill., has made known her attention of giving 1,000,000 dols. for a polytechnic institute in Peoria.—A Boston citizen, whose name is withheld, has given 100,000 dols. to establish a chair of Comparative Pathology in the medical school of Harvard University.—Mrs. J. S. T. Stranahan, of Brooklyn, has given 5000 dols. to the building fund of Barnard College.—The Catholic University has received 5000 dols. by the will of the Rev. Father Dougherty, of Honesdale, Pa.—It is expected that Mayor Strong will approve the Bill authorising the Board of Estimate and Apportionment to give the College of the City of New York 175,000 dols. a year instead of 150,000 dols., the amount it has received for several years.

AT the general meeting of Convocation of the University of London, held on Tuesday, it was resolved—"That some means should be devised for a more thorough preliminary investigation

than has hitherto been usual of the mathematical questions proposed to be set in the University examinations." The following resolutions were also carried. (1) That a special Committee of thirteen members, including the Chairman of Convocation, be nominated to prepare for presentation to any Statutory Commission which may be appointed a memorandum of points in the scheme of the Royal Commission in which modification is desirable, and with power to confer with such said Statutory Commission, and with the Senate or any Committee thereof. (2) That this special Committee consist of the following members :—The Chairman of Convocation, Dr. Allchin, Dr. Benson, Mr. Bompas, Mr. Stanley Boyd, Dr. Cave. Mr. Cozens-Hardy, Mr. Thiselton-Dyer, Dr. Heber Hart, Dr. Napier, Mr. Blake Odgers, Dr. Sansom, Prof. S. P. Thompson. (3) That the new and enlarged special Committee recommended for appointment in the report of the special Committee on the memorandum to be presented to such said Statutory Commission should have full powers, if it thinks fit, to prepare amendments to the London University Commission Bill and to have them proposed on behalf of Convocation in either House of Parliament.

AT a special meeting of the Technical Instruction Committee of the Cheshire County Council the following resolutions were adopted, and instructions given for them to be forwarded to the President and Vice-President of the Council.

(1) "That in the opinion of this Committee the Education Bill of this Session, as printed, will have the effect, by adding new subjects (not technical nor manual) for assistance out of the Customs and Excise grant, of making it impossible for the successors of this Committee, without recourse to a rate in aid, to continue the maintenance grants to those Science and Art Committees which their predecessors have, in good faith, on the assurance of her Majesty's Ministers in the past that the grant or its equivalent would not be withdrawn, fostered, or created. That the financial clauses of the Bill, confirming only a rate of one penny in the pound, in addition to the local taxation (Customs and Excise) grant, are inadequate for the work of secondary and technical education it is proposed the new Education Committee shall undertake."

(2) "That this Committee would respectfully urge upon her Majesty's Government that a County Council may have the option of nominating two school committees, one an elementary school committee, and the other a secondary school committee, with a view to secure for service in each committee members specially qualified for the work of each grade who would not have leisure time to attend to the two combined, and ventures to express a hope that for the purpose of education other than elementary the cost thereof may be wholly borne by the Imperial Exchequer, or, failing that, the Education Committee may have the benefit of at least a rate of *2d.* in the pound."

(3) "That, in the opinion of this Committee, Clause II., Subsection 3, relating to the performance by the education authority of the work of the numerous school attendance committees in the county, is impracticable, and cannot be undertaken by the education authority."

SCIENTIFIC SERIALS.

American Journal of Science, April.—The morphology of *Triarthrus*, by C. E. Beecher. Most of the recent advances in the knowledge of trilobite structure have come from the study of Triarthrus. Much time was spent by the author in carefully working out the numerous specimens from the abundant material in the Yale Museum. Altogether upwards of five hundred individuals with appendages more or less complete have been investigated; and at the present time all the important exoskeletal features have been seen and described. The appendages of *Triarthrus* are exceptionally long. It must have been a sort of "Daddy Long-legs" among the Trilobites, as *Scutigera* is among the Myriapoda. The delicacy of the appendages and ventral membrane of trilobites and their rarity of preservation are sufficient demonstration that these portions of the outer integument were of extreme thinness, and therefore perfectly capable of performing the function of respiration. The paper is accompanied by a plate showing a dorsal and a ventral view of a specimen fully restored.—Climatic zones in Jurassic times, by A. E. Ortmann. The author proves that the argument given by Neumayr for the non-existence or non-action of topographical differences upon the distribution of the Jurassic faunas is a complete failure. Only one point may be granted, that a separation by land was not present in an extensive manner. On the other hand, it is highly probable that on the one side differences of depth of the seas, on the other differences of facies, are the laws governing the faunistic differences. The first cause applies especially to the distinction of the Mediterranean and Middle-European provinces, the second to that of the Middle-European and Russian (Boreal) provinces.—Metamorphism of a gabbro occurring in St. Lawrence County, N.Y., by C. H. Smith, junr. The extreme effect of metamorphism on this gabbro has been to produce complete recrystallisation, yielding a granulitic structure. This metamorphism takes place in three stages. The first is marked by the formation of scapolite and some scaly hornblende, with little or no sign of crushing, the probable agents of change being pressure, heat, and solutions. In the second stage the effects of crushing are pronounced. All of the constituents are granulated, and the rock becomes more or less gneissoid. At the same time the scaly hornblende increases in quantity, seeming to reach its maximum in this phase of the rock. Finally, in the third stage, the rock undergoes complete recrystallisation, the newly-formed constituents being arranged normal to the pressure that has crushed the rock, and thus producing a pronounced gneissoid structure.—An occurrence of free gold in granite, by G. P. Merrill. A piece of quartz described as "gold ore, Sonora, Mexico," was found to be not superficially impregnated with gold, but to contain flecks of free gold throughout its substance. There is no other way of accounting for it other than by considering it a true constituent of the rock, crystallised from the original magma. It is completely embedded in the clear grassy quartz and unfissured felspars. No pyrite or other sulphides could be detected. This is believed to be a unique occurrence.

Wiedemann's Annalen der Physik und Chemie, No. 4.—On the nature of the X-rays, by D. A. Goldhammer. The author believes the X-rays to be not longitudinal light waves, but ultra-violet rays of extreme shortness. The absence of refraction would be quite consistent with this view, since in several theories of dispersion the index of refraction for infinitely short waves is unity. The absence of reflection would be due to the smallness of the waves compared with the unevenness of ordinary polished surfaces. This also explains the absence of polarisation. As regards the variation of absorption with the density simply, this is analogous to the absorption of light by aniline and other solutions, which simply depends upon their concentration. The author gives no reason against these rays consisting of longitudinal vibrations.—On the determination of overtones, by C. Stumpf. Careful investigations show that wherever overtones may influence the result of an experiment, the source of sound must always be specially tested as regards its composition, and that theoretical proofs of the simplicity of a tone are often misleading. Wherever simple tones are to be produced, the sound must be as faint as possible, or the overtones must be excluded by interference.—On the origin of contact electricity, by C. Christiansen. To establish a difference of potential between mercury and either zinc, cadmium, lead, or tin amalgam, the presence of oxygen is essential. Further experiments were made with hydrochloric and sulphurous acids, carbon bisulphide and nitrous oxide. Hydrochloric acids gave a polarisation effect with all the amalgams for which it was found in the case of oxygen, and for copper in addition. SO_2 gave effects with zinc and cadmium. The other gases gave no effect.—Polarisation and resistance of a galvanic cell, by Franz Streintz. The author shows that the determination of galvanic polarisation in an electrolytic cell in a closed circuit is an impossibility, since the "resistance" of the cell is an unknown function of the current strength.—The iron sphere in a homogeneous magnetic field, by O. Grotrian. By induction experiments made with coils of wire laid over an iron sphere so as to cut off segments of various sizes the author shows that the sphere is evenly magnetised throughout its substance, as predicted by theory. The result is not affected by the direction of "grain" of wrought iron.—Diminution of the intensity of sound with the distance, by K. L. Schaefer. Sound does not diminish in intensity strictly with the square of the distance, but at first more slowly, and then more rapidly. This was proved by means of a telephone attached to a clock and brought to different degrees of sensitiveness.

Memoirs (*Zapiski*) *of the Caucasian Branch of the Russian Geographical Society*, vol. xviii., Tiflis, 1896.—Review of the atmospheric sediments fallen in Caucasia during the spring and summer of 1894, by A. Woznesensky, with four maps.—A journey to the mountain region of the district Tchernomorsk, by N. Albof, with a map of the district, 6·7 miles to the inch. The author has visited, for botanical purposes, some of the least-known valleys of the region, and now gives the diary of his journey.—Studies in the geographical botany of Western Transcaucasia, by the same author. The article is full of valuable data. Several interesting finds are mentioned, such as the new species *Amphoricapus elegans*, and a *Campanula*, which so much exceeds all known species of the same genus by its beauty, that M. Albof proposes for it the name of *Campanula regina*, and remarks that its general shape so much differs from all other now living *Campanula* species that it must be, without doubt, a remainder from a foregone geological flora.—On the Kumyks, an anthropological sketch, by J. Pantukhof.—The Pshaves and their land, by M. Khizanachwili.—A journey to the central part of the land of the Chechenes, by Mdme. A. Rossikof, with a map, three miles to the inch, of this very little part of the main ridge.—A statistical description of the governments of Baku and Kars, from the "Caucasian Calendar."—The state of the glaciers on the northern slope of the Caucasus, by K. Rossikof, being the results of the measurements of the motion of several glaciers in 1893 and 1894; and on the present state of the desiccating lakes of the northern slopes of the Caucasus, by the same author. The same volume contains, as a supplement, a most welcome atlas of ethnographical maps of Transcaucasia, drawn by the Secretary of the Society, E. Kondratenko. The maps are the result of many years' work. The classification of the more than sixty different stems which inhabit Transcaucasia is the result of the remarkable works of Baron Uslar and his follower, M. Zagursky; and the numerical data as to the numbers of inhabitants belonging to each stem are obtained from a census made in the years 1886–1891. The maps, on the scale of thirteen miles to the inch, are seven in number, and represent the governments of Tiflis, Kutais, Baku, Elizabethpol, Daghestan, Erivan, and Kars. The limits of each village community are indicated, and the nationality which prevails in each village is shown in different colours; while, on the borders of each map, special coloured diagrams give the ethnographical composition and the numbers of each nationality for each town and district, as well as for the whole government, so that one sees at a glance their numerical proportions. Full tables of figures are given by M. E. Kondratenko in the text of the *Zapiski*. The value of this work is enhanced by an ethnographical map of Turkish Armenia and Kurdistan, published in the same volume. It is based upon V. Cuinet's statistics, given in his work, "La Turquie d'Asie," and shows in different colours the percentage of Turks and Armenians in each *kaza*, or sub-district.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 30.—"The Total Eclipse of the Sun, April 16, 1893. Report and Discussion of the Observations relating to Solar Physics." By J. Norman Lockyer, C.B., F.R.S.

The memoir first gives reports by Mr. Fowler and Mr. Shackleton as to the circumstances under which photographs of the spectra of the eclipsed sun were taken with prismatic cameras in West Africa and Brazil respectively on April 16, 1893. These are followed by a detailed description of the phenomena recorded, and a discussion of the method employed in dealing with the photographs. The coronal spectrum and the question of its possible variation, and the wave-lengths of the lines recorded in the spectra of the chromosphere and prominences, are next studied.

Finally, the loci of absorption in the sun's atmosphere are considered.

The inquiry into the chemical origins of the chromospheric and prominence lines is reserved for a subsequent memoir.

The general conclusions which have been arrived at are as follows:—

(1) With the prismatic camera, photographs may be obtained with short exposures, so that the phenomena can be recorded at short intervals during the eclipse.

(2) The most intense images of the prominences are produced by the H and K radiations of calcium. Those depicted by the rays of hydrogen and helium are less intense, and do not reach to so great a height.

(3) The forms of the prominences photographed in monochromatic light (H and K), during the eclipse of 1893, do not differ sensibly from those photographed at the same time with the coronagraph.

(4) The undoubted spectrum of the corona in 1893 consisted of eight rings, including that due to 1474 K. The evidence that these belong to the corona is absolutely conclusive. It is probable that they are only represented by feeble lines in the Fraunhofer spectrum, if present at all.

(5) All the coronal rings recorded were most intense in the brightest coronal regions, near the sun's equator, as depicted by the coronagraph.

(6) The strongest coronal line, 1474 K, is not represented in the spectrum of the chromosphere and prominences, while H and K do not appear in the spectrum of the corona, although they are the most intense radiations in the prominences.

(7) A comparison of the results with those obtained in previous eclipses confirms the idea that 1474 K is brighter at the maximum than at the minimum sun-spot period.

(8) Hydrogen rings were not photographed in the coronal spectrum of 1893.

(9) D_3 was absent from the coronal spectrum of 1893, and reasons are given which suggest that its recorded appearance in 1882 was simply a photographic effect due to the unequal sensitiveness of the isochromatic plate employed.

(10) There is distinct evidence of periodic changes of the continuous spectrum of the corona.

(11) Many lines hitherto unrecorded in the chromosphere and prominences were photographed by the prismatic cameras.

(12) The preliminary investigation of the chemical origins of the chromosphere and prominence lines enables us to state generally that the chief lines are due to calcium, hydrogen, helium, strontium, iron, magnesium, manganese, barium, chromium, and aluminium. None of the lines appear to be due to nickel, cobalt, cadmium, tin, zinc, silicon, or carbon.

(13) The spectra of the chromosphere and prominences become more complex as the photosphere is approached.

(14) In passing from the chromosphere to the prominences, some lines become relatively brighter but others dimmer. The same line sometimes behaves differently in this respect in different prominences.

(15) The prominences must be fed from the outer parts of the solar atmosphere, since their spectra show lines which are absent from the spectrum of the chromosphere.

(16) The absence of the Fraunhofer lines from the integrated spectra of the solar surroundings and uneclipsed photosphere shortly after totality need not necessarily imply the existence of a reversing layer.

(17) The spectrum of the base of the sun's atmosphere, as recorded by the prismatic camera, contains only a small number of lines as compared with the Fraunhofer spectrum. Some of the strongest bright lines in the spectrum of the chromosphere are not represented by dark lines in the Fraunhofer spectrum, and some of the most intense Fraunhofer lines were not seen bright in the spectrum of the chromosphere. The so-called "reversing layer" is therefore incompetent to produce the Fraunhofer spectrum by its absorption.

(18) Some of the Fraunhofer lines are produced by absorption taking place in the chromosphere, while others are produced by absorption at higher levels.

(19) The eclipse work strengthens the view that chemical substances are dissociated at solar temperatures.

May 7.—"On the Occurrence of the Element Gallium in the Clay-Ironstone of the Cleveland District of Yorkshire." By Prof. W. N. Hartley, F.R.S., and Hugh Ramage.

The evidence of the existence of gallium in the ore and in the metal rests on the measurements of the wave-lengths of the lines in a large number of photographed spectra and upon the relative strengths of the lines in the different materials examined and in the precipitates obtained therefrom.

Examples are given showing the nature of this evidence.

Chemical Society, April 23.—Mr. A. G. V. Harcourt, President, in the chair.—The following papers were read:—The constitution of the cereal celluloses, by C. F. Cross, E. J. Bevan, and C. Smith. The cereal celluloses may be resolved by acids into a residue of normal cellulose and a soluble furfuroid con-

stituent; the latter seems to be a pentosemonoformal of the constitution $C_5H_8O_3\left\langle\begin{matrix}O\\O\end{matrix}\right\rangle CH_2$.—On a new compound of cobalt and a rapid method of detecting cobalt in presence of nickel, by R. G. Durrant. On adding excess of an alkali bicarbonate, and then hydrogen peroxide, to a solution of cobalt salt, a green solution, which appears to contain a salt of cobaltic acid H_2CoO_4, is obtained.—Ethereal salts of optically active malic and lactic acids, by T. Purdie and S. Williamson. The specific rotations of the ethereal salts of active lactic and malic acids vary with the method of preparation of the substances; the variations in rotatory power do not seem to be altogether due to the occurrence of partial racemisation.—Metadichlorobenzene, by F. D. Chattaway and R. C. T. Evans. A convenient method of preparing large quantities of 1 : 3-dichlorobenzene from acetanilide is described.—On the temperature of certain flames, by W. N. Hartley.—The determination of the composition of a white sou by a method of spectrum analysis, by W. N. Hartley. A photograph of the spectrum of a white sou coined during the French Revolution of 1798 was taken, and by comparison with the quantitative spectra of the constituent metals, the composition of the coin was determined within certain limits; alloys, the compositions of which varied within these limits, were then made, and their spark spectra photographed. An alloy, consisting of 13·93 per cent. of lead, 72·35 of copper, 0·85 of iron, and 12·70 per cent. of zinc, was ultimately obtained, which gave a spark spectrum identical with that of the sou; the coin consequently has the above composition.—Halogen additive products of substituted thiosinnamines, by A. E. Dixon.—Acidic thiocarbimides, thioureas, and ureas, by A. E. Dixon.—Apparatus for the detection of boric acid, by W. M. Doherty. A method is given for the detection of boric acid in milk, wine, or other substance, depending on the fact that when boric acid is heated in a current of coal-gas which is then burnt, a characteristic colouration is imparted to the flame.

Zoological Society, April 29.—Sir William H. Flower, K.C.B., F.R.S., President, in the chair.—After the Auditors' Report had been read, and other preliminary business had been transacted, the Report of the Council on the proceedings of the Society during the year 1895 was read by Mr. P. L. Sclater, F.R.S., the Secretary. The total receipts of the Society for 1895 amounted to £26,958 9*s*. 1*d*., showing an increase of £1851 8*s*. 6*d*. as compared with the previous year. This increase was attributable to the prevalence of fine weather during the summer and autumn of 1895, and also to the acquisition of a giraffe, and several other specially interesting additions to the Society's menagerie. A new edition of the list of animals in the Society's collection, of which the last (the eighth) was published in 1883, has been prepared under the direction of the Secretary. It contains a list of all the specimens of vertebrated animals that had been received by the Society during the past twelve years. This volume is now going through the press, and will, it is hoped, be ready for issue before the close of the present year. The number of visitors to the gardens in 1895 was 665,326, which was greater than it had been in any year during the past ten years. The corresponding number in 1894 had been 625,538. The number of animals in the Society's collection on December 31 last was 2369, of which 768 were mammals, 1267 birds, and 334 reptiles. Amongst the additions made during the past year, twelve were specially commented upon as of remarkable interest, and in most cases new to the Society's collection. Amongst these were a male lion from Somali-land (presented by her Majesty the Queen), a female South African giraffe, a pair of brindled gnus, a pair of sable antelopes, a Brazilian three-banded armadillo, a male Panolia deer from Southern China, an Alexandra parrakeet from the interior of Australia, a frilled lizard from Western Australia, a martial hawk-eagle from British East Africa, and two examples of Forsten's lorrikeet. The Report having been adopted, the meeting proceeded to elect the new Members of Council and the Officers for the ensuing year. The usual ballot having been taken, it was announced that General the Hon. Sir Percy Feilding, K.C.B., Prof. Alfred Newton, F.R.S., Sir Thomas Paine, Mr. E. Lort Phillips, and the Lord Walsingham, F.R.S., had been elected into the Council in the place of the retiring Members; and that Sir William H. Flower had been re-elected President, Mr. Charles Drummond Treasurer, and Mr. P. L. Sclater Secretary to the Society for the ensuing year.

PARIS.

Academy of Sciences, May 4.—M. A. Cornu in the chair.—On the theory of gases, by M. J. Bertrand. A critical examination of the well-known formula of Maxwell for the relation between the velocities of the gaseous molecules and their components in any arbitrarily chosen direction. This formula is described as necessarily absurd, since it gives an apparent solution of a problem insoluble from its very nature.—On the constitution and history of the lunar surface, by MM Lœwy and Puiseux. The results of a study of a new serie of lunar photographs tend to show that it is unnecessary to assume the action of natural forces other than those now at work on the earth to explain the condition of the surface of the moon.—On the birds and butterflies observed in the centre of an intertropical tempest, by M. H. Faye. The author shows that the occurrence of birds and insects in the calm centre of a cyclone, a fact frequently observed, is in full accord with his theory of storms.—Concerning hematozoa in marsh-fever, by M. A. Laveran. Although the presence of amœboid parasites in the blood during marsh-fever is now well established, there is hardly any ground for the assumption of distinct species peculiar to each variety of the disease, one for tertiary ague, another for quaternary ague, and a third giving rise to irregular fevers. This assertion is supported both by the microscopical study of the parasite and by the clinical study of the disease.—Observations of the new Swift comet (*b* 1896 = 1896, April 13), made at the Observatory of Paris by M. G. Bigourdan.—On the approximate development of the perturbation function in the case of inequalities of a high order, by M. Maurice Hamy.—A property of movements on a surface, by M. Hadamard.—On the absorption of light by media possessing rotatory power, by M. E. Carvallo.—Electrostatic deviation of the kathode rays, by M. G. Jaumann. A reply to some criticisms and suggestions of M. Poincaré. By immersing the vacuum tube in oil forming the anode, the rays are much reduced in intensity, and in this state are strongly deviated by electrostatic forces.—Observations on the preceding communication, by M. Poincaré. The suggestion of M. Jaumann that inside a Crookes' tube the lines of force are rectilinear, is directly opposed to the conclusion drawn by Hertz from his experiments.—Apparatus for measuring currents of high frequency, by MM. G. Goiffe and E. Meylan.—Reply to some observations of M. Aug. Righi, by MM. L. Benoist and D. Hurmuzescu.—On the relation between the maximum production of the X-rays, the degree of vacuum and the form of the tubes, by MM. Victor Chabaud and D. Hurmuzescu. The pressure giving the maximum result varies with the shape of the tube. A form of tube is figured giving a choice of two anodes from which excellent results were obtained.—Radiography; some applications to the physiology of motion, by MM. Imbert and Bertin-Sans.—On a new method of preparing synthetically urea, and its symmetrical derivatives, by M. P. Cazeneuve. The carbonate of guaiacol, now easily obtained commercially, on treatment with alcoholic ammonia or amines, gives the corresponding urea in nearly theoretical yield.—Transformation of tariric and stearoleic acids into stearic acid, by M. A. Arnaud. This reduction, which is not effected by sodium amalgam, takes place readily with hydriodic acid and amorphous phosphorus.—On the presence, in the *Monotropa Hypopithys*, of a glucoside of methyl-salicylic ether, and on the hydrolysing ferment of this glucoside, by M. E. Bourquelot.—On maize, by M. Balland. Some analyses showing the superior nutritive power of Indian corn as compared with wheat.—On zeolites and the substitution of the water they contain by other substances, by M. G. Friedel. The dehydrated mineral readily takes up sulphuretted hydrogen, carbonic acid, hydrogen, and even atmospheric air, the last to such an extent as to render it impossible to determine the amount of water by loss or ignition.—On the Annelids at great depths in the Bay of Biscay, by M. Louis Roule. The results of soundings from the *Caudan* in April 1895.—On the first cause of potato-scab, by M. E. Roze.—On the age of the ophitic eruption of Algeria, by M. L. Gentil.—On a method of photographing the retina, by M. V. Guinkoff.—The fermentation of uric acid by micro-organisms, by M. E. Gerard. In the experiments cited the uric acid was split up into urea and ammonium carbonate.—Researches on the serotherapy of urinary infection, by MM. J. Albarran and E. Morny.—On the relations between the composition of the blood, the quantity of hæmoglobin, and the general state of the organism, by M. P. Lafon.—Projection of a thermometer column on a sensitive plate, by means of the Röntgen rays, by M. H. Bentéjac.

AMSTERDAM.

Royal Academy of Sciences, March 28.—Prof. van de Sande Bakhuyzen in the chair.—Prof. Kamerlingh Onnes exhibited a series of extremely clear photographs, obtained with Röntgen rays by Prof. Haga at Groningen. The exposure did not last longer than one minute.—Prof. Kamerlingh Onnes presented, on behalf of Dr. Siertsema, a paper to be published in the report of the meeting, on measurements of magnetic rotation dispersion in gases.—Prof. Franchimont on the action of nitric acid upon methyl and dimethyl amides at the ordinary temperature. The author showed to what extent the action depends upon the acid-residue of the amides, and proved that the same rules also hold good for the piperidides. For this purpose the author, in conjunction with Dr. van Erp, examined oxal-piperide, which enters into an unstable compound with nitric acid, but is not otherwise influenced, resembling in this tetramethyloxamide, previously studied in conjunction with Mr. Rouffaer. The author and Dr. Taverne examined (1) trichloracetpiperidide, a beautifully crystallised substance, fusing at 45°; (2) benzolsulphonepiperidide; (3) picrylpiperidide; and, as they had expected, they found that the first was not influenced, the second yielded nitropiperidine, and the third a picryldehydronitropiperidide as a red, beautifully crystallised body, fusing at 95°.—Prof. Franchimont further treated of the action of alkalies upon nitramines, in examining which action Dr. van Erp found that a great quantity of nitrous acid is formed. With some nitramines, as nitrohydantoin, nitromethylhydantoin, nitrolacetylureum, nitroamidoacetamide, when treated with baryta-water, the formation of nitrous acid already takes place at a low temperature; others, as nitroacetonyl-urea, ethylenedinitro-urea, dinitroglycoluril, &c., behave differently.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, MAY 14.

ROYAL INSTITUTION, at 3.—The Art of Working Metals in Japan: W. Gowland.
SOCIETY OF ARTS, at 4.30.—Tea Planting in Darjeeling: G. W. Christison.
MATHEMATICAL SOCIETY, at 8.—On the Application of the Principal Function to the Solution of Delaunay's Canonical System of Equations: Prof. E. W. Brown.
INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Influence of the Shape of the Applied Potential Difference Wave on the Iron Losses in Transformers: Stanley Beeton, C. Perry Taylor, and I. M. Barr.

FRIDAY, MAY 15.

ROYAL INSTITUTION, at 9.—Cable-laying on the Amazon River: Alexander Siemens.
EPIDEMIOLOGICAL SOCIETY, at 8.
QUEKETT MICROSCOPICAL CLUB, at 8.

MONDAY, MAY 18.

SOCIETY OF ARTS, at 8.—Applied Electro-chemistry: James Swinburne.
ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Journey from Talifu to Assam: H.R.H. Prince Henry of Orleans.
VICTORIA INSTITUTE, at 4.30.—Climate in India: Grant "Bey."

TUESDAY, MAY 19.

ROYAL INSTITUTION, at 3.—Ripples in Air and on Water: C. V. Boys, F.R.S.
SOCIETY OF ARTS, at 8.—Bronze Casting in Europe: George Simonds.
ZOOLOGICAL SOCIETY, at 8.30.—On an interesting Variation in the Pattern of the Teeth of a Specimen of the Common Field-Vole: G. E. H. Barrett-Hamilton.—Contributions to the Anatomy of Picarian Birds. No. III. The Anatomy of the Alcedinidæ: F. E. Beddard, F.R.S.
INSTITUTION OF CIVIL ENGINEERS, at 8.—The Magnetic Testing of Iron and Steel: Prof. J. A. Ewing, F.R.S.—Magnetic Data of Iron and Steel; Horace F. Parshall.
ROYAL STATISTICAL SOCIETY, at 5.
PATHOLOGICAL SOCIETY, at 8.30.—Annual Meeting.
ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Photo-mechanical Methods in Austria: Ignatz Herbst.
ROYAL VICTORIA HALL, at 8.30.—A Visit to Armenia: Prof. A. V. Markoff.

WEDNESDAY, MAY 20.

SOCIETY OF ARTS, at 8.—Orthochromatic Photography: Captain W. de W. Abney, F.R.S.
ROYAL METEOROLOGICAL SOCIETY, at 7.30.—The Exposure of Anemometers: Richard H. Curtis.
ROYAL MICROSCOPICAL SOCIETY, at 8.

THURSDAY, MAY 21.

ROYAL SOCIETY, at 4.30.—On the Changes produced in Magnetised Iron and Steels by cooling to the Temperature of Liquid Air: Prof. J. Dewar, F.R.S., and Dr. J. A. Fleming, F.R.S.—Note on the Larva and of the Post-Larval Development of Leucosolenia variabilis, n. sp., with remarks on the Development of other Arconidæ: E. A. Minchin.—Helium and Argon. Part III. Experiments which have yielded Negative Results: Prof. Ramsay, F.R.S., and Dr. Collie.—On the Amount of Argon and Helium contained in the Gas from the Bath Springs: Lord Rayleigh, Sec. R.S.
ROYAL INSTITUTION, at 3.—The Art of Working Metals in Japan: W. Gowland.
CHEMICAL SOCIETY, at 8.—The Diphenylbenzenes. I. Metadiphenylbenzene: F. D. Chattaway and R. C. T. Evans.—Derivatives of Camphoric Acid: Dr. F. S. Kipping.—Some Substances exhibiting Rotatory Power both in the Liquid and Crystalline states: W. J. Pope.

FRIDAY, MAY 22.

ROYAL INSTITUTION, at 9.—Hysteresis: Prof. J. A. Ewing, F.R.S.
PHYSICAL SOCIETY, at 5.—On Dielectrics: R. Appleyard.—The Field of an Elliptical Current: J. Viriamu Jones.—An Instrument for Measuring Frequency: A. Campbell.

SATURDAY, MAY 23.

GEOLOGISTS' ASSOCIATION (Paddington at 11.45).—Excursion to Chippenham, Calne, Kellaways, and Corsham.
YORKSHIRE NATURALISTS' UNION, at Hellifield.—Four Days' Excursion for the investigation of Bowland.

BOOKS, PAMPHLET, and SERIALS RECEIVED.

BOOKS.—Alembic Club Reprints. No. 12. The Liquefaction of Gases: M. Faraday (Edinburgh, Clay).—Report on the Work of the Horn Scientific Expedition to Central Australia. Part 2. Zoology (Dulau).—Hausaland: C. H. Robinson (Low).—A Theoretical and Practical Treatise on the Manufacture of Sulphuric Acid and Alkali: Dr. G. Lunge, Vol. 3, 2nd edition (Gurney).—Electric Lighting and Power Distribution: W. P. Maycock, 3rd edition, 2 Vols. Vol. 1 (Whittaker).—The Whence and the Whither of Man: Prof. J. M. Tyler (Blackwood).—Graphical Calculus: A. H. Barker (Longmans).—A Handbook to the Order Lepidoptera: W. F. Kirby. Part 1. Butterflies, Vol. 2 (Allen).—Les Rayons X: Dr. C. E. Guillaume, deux édition (Paris, Gauthier-Villars).—Regenwaarnemingen in Nederlandsch-Indie, 1894 (Batavia).—Observations made at the Magnetical and Meteorological Observatory at Batavia, 1894 (Batavia).
PAMPHLET.—On Germinal Selection: A. Weismann (Open Court Publishing Company).
SERIALS.—Bulletin de L'Académie Royale des Sciences, 1896, No. 3 (Bruxelles).—Centralblatt für Anthropologie, &c., 1896, Heft 2 (Breslau).—American Journal of Science, May (New Haven).—Journal of the Franklin Institute, May (Philadelphia).—Psychological Review, May (Macmillan).

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THURSDAY, MAY 21, 1896.

SOCIOLOGY.

The Principles of Sociology; an Analysis of the Phenomena of Association and of Social Organisation. By Franklin Henry Giddings, M.A., Professor of Sociology in Columbia University in the City of New York. Pp. xvi + 476. (New York and London: Macmillan and Co., 1896.)

WITH extensive learning and a good deal of original speculation, Prof. Giddings has written a very useful general introduction to sociology. The scope and nature of this recently established science are not yet well understood, and hitherto it has been difficult to refer to any one book from which they could be learnt; for Comte is out of date; Mr. Spencer's great work is still incomplete, though already rather terrifying in its proportions; and the greater part of the information obtainable on the subject must be sought in innumerable monographs on primitive law, marriage, religion, art, in volumes, essays, and the journals of learned societies. In the present volume, however, the most interesting lines of sociological inquiry are indicated, and the best ascertained results are collected, critically examined, and scientifically arranged within a moderate compass.

The preliminary discussions of the province of sociology and its logical methods of research, attest the care with which the author has prepared for his task by studying the physical sciences. Some passages in chapter iii., on method, may perhaps be considered fanciful, but they do not prevent his coming to sound conclusions.

The second book is descriptive and classificatory, dealing with the facts of population, its growth, diffusion, and localisation; with the social mind, its traditions and standards (there is no mysticism about it); with social composition according to tribes and nations, and social constitution or organisation for government, industry, &c.

Then follows an investigation of the history of society; the place of man's origin, the origin of races, and of the great groups of ideas that constitute law, art, religion, &c.; the growth of the tribe in its metronymic and patronymic forms, and finally of civilised peoples.

The fourth and last book formulates the ultimate causes and laws of social evolution, as objectively a conflict of physical forces tending to equilibrium, and subjectively the production of personality and of forms of association that partly result from and partly determine the characters of human beings.

The treatment throughout is scientific: it is well proportioned, and fully illustrated from history and anthropology. If fault must be found, it may perhaps be said that there are some needless pages in Book iii. chapter ii., where Prof. Giddings tries to frame hypotheses as to the birthplace of our race and the origin of races; inquiries which, in the present state of our knowledge, can only lead to a submerging of the halfpennyworth of fact by floods of speculation. And the first chapter of Book iv., on the physical interpretation of the social process, should be much expanded and illustrated. As it stands, it is intelligible only to trained readers.

There are also, of course, in so comprehensive a work, a good many disputable positions, two of which may be selected for special comment. In Book iii. chapter iv., on demogenic association, Prof. Giddings distinguishes three stages in the growth of civilised societies: (1) the Military-Religious, (2) the Liberal-Legal, (3) the Economic-Ethical. Noticing previous attempts to demarcate such epochs of progress, he complains that Hegel's doctrine of successive steps in the acquisition of freedom or self-realisation, and Comte's "law of the three states," are alike one-sidedly subjective, and fail to give any account of the structural changes of society. Mr. Spencer, again, recognises only two stages, the military and industrial, corresponding on the whole to (1) and (3) of the author's own divisions. But this criticism rests upon an oversight with regard to Comte. Turning to Comte's chapters on sociology, it will be seen that the indication of the military and industrial stages of society is due to him. He regards them as naturally coinciding respectively with the theological and positive stages of explanation; and, further, he indicates an intermediate phase of social organisation similar to Prof. Giddings' (2), the Liberal-Legal, and naturally coinciding with the age of metaphysical explanation. This intermediate stage, however, in both organisation and explanation, he treats as essentially transitional and as wanting the relative stability of militarism and industrialism. How comparatively unimportant it is in universal history (though important to us who have not yet escaped from it), may be seen at p. 301 of this work, where its extent in modern history is indicated as dating from the Renaissance: 500 years! Merely a list of revolutions! Mr. Spencer seems to be fully justified in not giving to this unstable period the rank of those forms of culture of which one endured, and the other may endure, for thousands of generations. As for Comte, he has been adulated and repudiated enough, and would now gain much by getting bare justice.

Again, in his first chapter, Prof. Giddings, after observing that sociology, having for its object phenomena which, on the one hand, may be viewed as a redistribution of matter and motion, and, on the other, as effects of knowledge and volition, must seek its explanations in the co-operation of physical and psychical causes, according to laws subjective and objective, coinciding and verifying one another, goes on to say that he accepts Mr. Spencer's objective interpretation of the social process, as a "formal evolution through the equilibration of energy," but that an adequate conception of the process on the subjective side is still wanting. He then offers to supply the want thus:—

"The original and elementary subjective fact in society is *the consciousness of kind*. By this term I mean a state of consciousness in which any being, whether low or high in the scale of life, recognises another conscious being as of like kind with itself" (p. 17.)

But surely this cannot be the fact he is in quest of; for the "consciousness of kind" is mainly a fact of perception; whereas what he needs is something corresponding to the physical energy that moulds societies considered objectively, and this subjectively can only be a fact of volition. The fact that is wanted, moreover, must not only correspond with the physical cause of the

social process, but also in its consequences with the physical result, namely, the establishment of a moving equilibrium. Both these requirements are met by our old-fashioned friend utility: desires are the psychical causes; and the maximum satisfaction with the nearest approach to equal conditions, may one day correspond with the nearest approach to equilibrium. No doubt the consciousness of kind is a condition of the development of social life, as in the phenomena of sympathy and (to take the social process pretty early) in bisexual generation. But it may be presumed that the consciousness of kind, sympathy, and bisexual generation are all subordinate to objective utility (survival), or they could never have existed at all; and the connection of subjective with objective utility through the laws of pleasure and pain is well known.

It is a pleasure to add that this unpromising theory at the outset of the book does very little harm in the sequel, and by no means prevents the author's knowledge and penetration from producing very interesting and instructive work.

CARVETH READ.

COCOA CONNOTATIONS.

Cocoa: All about It. By Historicus. Pp. 99. (London: Sampson Low, Marston, and Co., Limited, 1896.)

IN this book the author has managed to justify his title, for if he has not reproduced *all* that has been written and said about cocoa, he has strung together a large number of extracts from early records referring to its history, cultivation, and uses. About one-half the book is devoted to these subjects, and the remainder to the manufacture, the value of cocoa as food, its adulterations, and finally a few pages to the subject of vanilla as a flavouring agent to chocolate.

The chief interest of the book, however, will be found in the first two chapters, namely, "The History and Cultivation of the Cocoa Plant," and "History of the Use of Cocoa"; and we say this advisedly, for the author has apparently been at some pains in collating these extracts, which do not appear in every essay on cocoa, while cocoa manufacture, its value as food, and its adulterations have been the subject of many themes since it has become such a popular and wide-spreading beverage. It may be a surprise to some persons to know that though cocoa is a comparatively modern drink with us, it was well known to the early Mexicans. The author says: "Our knowledge of cocoa as an article of diet dates from the discovery of the Western World in 1494 by Columbus, who, we are told, took home with him samples of the article; and from the subjugation of Mexico by Cortez in 1521. History informs us that the Spaniards were the first who tasted chocolate, which was part of their spoil in the conquest of Mexico." An additional tribute to the early use of cocoa is given from a MS. in the British Museum, "written in Old English characters and entitled 'A Voyage to the West Indies and New Spain' (Yucatan) made by John Chilton in the year 1560. He says: 'So we were provided of victualls till we came where Townes were in the province of Soconusco, where groweth Cacau, w^{ch} the Christianes carrye from thence unto Nova Hispaniola because y^{t} will not grow in a cold countrye. . . . Their chiefest marchandize is Cacau.'" It is not a little remarkable that one of the finest qualities of cocoa at the present time is produced at Soconusco on the coast of Guatemala. The following extract from an account of the rise and growth of the West Indies, written in 1690, is given as showing an early attempt and failure by the English to cultivate cocoa.

"Cocoa," it is said, "is now a commodity to be regarded in our colonies, though at first it was the principal invitation to the peopling of Jamaica, for whose walks the Spaniards left behind them there, when we conquered it, produced such prodigious profit with so little trouble that Sir Thos. Modiford and several others set up their rests to grow wealthy therein, and fell to planting much of it, which the Spanish slaves had always foretold would never thrive, and so it happened, for though it promised fair, and throve finely for five or six years, yet still at that age when so long hopes and cares had been wasted upon it, withered and died away by some unaccountable cause, though they imputed it to a black-worm or grub which they found clinging to its roots, and did it not almost constantly die before, would come into perfection in fifteen years' growth and last till thirty, thereby becoming the most profitable tree in the world, there having been £200 sterling made in one year of an acre of it. But the old trees being gone by age, and few new thriving as the Spanish negroes foretold, little or none now is produced worthy the care and pains in planting and expecting it. Those slaves gave a superstitious reason for its not thriving, many religious rites being performed at its planting by the Spaniards, which these slaves were not permitted to see. But it is probable that where a nation, as they, removed the art of making cochineal and curing vanilloes into their island provinces, which were the commodities of those islands in the Indians' time, and forbade the opening of any mines in them for fear some maritime nation might be invited to the conquering of them, so they might likewise in their transplanting cocoa from the Caracas and Guatemala conceal wilfully some secret in its planting from their slaves, lest it might teach them to set up for themselves, by being able to produce a commodity of such excellent use for the support of man's life, with which alone and water some persons have been necessitated to live ten weeks together without finding the least diminution of health or strength."

The value in which cocoa is now held as an article of diet, seems from the foregoing paragraph to have been established so long ago as 1690, and its cultivation and consumption still goes on at a marvellous rate. The processes of collecting the pods, extracting the seeds, fermenting, drying, &c., which are more or less generally known, are carefully detailed in the succeeding pages, and it is pointed out that if well cured a cocoa-bean should have the outer skin hard, crisp, and separating easily from the seed inside, which should be firm, bright, and should break readily on pressure, forming the familiar cocoa-nibs of commerce.

On the subject of adulteration, to which cocoa and chocolate lend themselves so readily, and to which so much attention has of late years been drawn, it is curious to note the following paragraph.

"So far back as 1640 in 'A Curious Treatise of the Nature and Quality of Chocolate,' by Antonio Colmenero, which was translated from the Spanish into English, there are some remarkable statements as to the value of chocolate, but the writer recognises the mischief that

adulteration had already done. He says: 'Those who mix maize in the chocolate do very ill, because these grains do beget a very melancholy humour, and those which mix it in this confection, do it only for their profit.'"

The book is illustrated by numerous full-page and smaller illustrations, and is well printed on thick, glazed paper.

THE CHEMISTRY OF ENGINEERING.

Chemistry for Engineers and Manufacturers. A Practical Text-book. By Bertram Blount, F.I.C., F.C.S., and A. G. Bloxam, F.I.C., F.C.S. Volume I. *Chemistry of Engineering, Building, and Metallurgy.* Pp. x + 244. 35 illustrations. (London: Charles Griffin and Co., Limited, 1896.)

THIS book gives a general view of chemical technology, and is intended for the use of engineers, managers of works, and students. It is meant to be read, and not to be treated as a book of reference, and therein differs from the larger works which have already covered the same ground. The authors have confined themselves to explaining the general chemical principles underlying each process, working details and exact descriptions of plant being omitted. Thus the manager of works engaged on a particular process can probably, by perusing this book, find out as much as he desires about any other typical process, although it is perhaps unlikely that he will learn from it much regarding his own business. It is to be regretted that in pursuance of their plan of avoiding all semblance of a book of reference, the authors have in no case indicated where further information can be obtained to supplement their own accounts. The volume is divided into two parts, the first part dealing with the chemistry of engineering and building, and the second with metallurgy. These two parts are very unequal in merit, the first being what it claims to be, a practical treatise, which will doubtless be much appreciated by manufacturers. In this part the accounts given of fuels, and particularly that of gaseous fuel, are useful summaries, and the chapters on steam-raising and on lubricants contain a considerable amount of practical information. These sections will be of value in enabling an owner of machinery or user of power to detect causes of waste, and to realise when saving may be effected by calling in expert assistance.

The part devoted to metallurgy is much less satisfactory. It is evident that, as the attempt has been made to compress an account of the whole art into 104 pages, only the barest outlines of the various processes could be given. Among the unfortunate results of this are that the Patio process for extracting silver from its ores, and the cyanide process for extracting gold, are each dismissed in half a page, though in these cases the chemical actions are complicated and the mechanical arrangements of secondary importance. Such paragraphs serve no useful purpose. There are more mistakes in this part than should have been allowed to creep in, this constituting another point of difference between the two parts. For example, in describing the wet process of copper extraction, the reason for preventing the temperature from rising much above 38° C. is incorrectly stated, the true reason being that the production of ferric salts is favoure by higher temperatures; moreover, a little-used method of keeping down the percentage of ferric salts in the solution is given, while no allusion is made to the ordinary one, viz. the passage of the liquid through a layer of cupriferous pyrites, rich in copper. Again, on p. 214, sulphurous acid is given as one of the agents used to precipitate gold from the solutions obtained in the chlorination process, the fact being that it is only employed to prepare solutions for the passage of sulphuretted hydrogen, which is not mentioned. It may be a hard saying, but there is little doubt that the whole book would have been improved if the part on metallurgy had been left out. Space could then have been found to expand here and there the first part, which, excellent as it is, might thus have been made still more useful.

OUR BOOK SHELF.

Elementary Practical Physics. By William Watson, B.Sc. (London: Longmans, Green, and Co., 1896.)

Elementary Practical Chemistry. By G. S. Newth, F.I.C. (London: Longmans, Green, and Co., 1896.)

WE have long deplored the unfortunate division between theoretical and practical chemistry in many schools and classes, and have been convinced that, alike for educational and utilitarian purposes, physics was a neglected instrument; therefore, very heartily do we welcome the new movement of which these books are a manifestation.

Each volume is described on its title-page as a "laboratory manual for use in organised science schools." Each is written to the new syllabus of the South Kensington Science and Art Department, and each gives excellent directions for setting up (and often for constructing) apparatus, and for taking observations to demonstrate the chief phenomena, and to verify the fundamental laws, of chemistry and physics respectively. In the physics we are glad to see that nearly all the experiments are of a quantitative character; in the chemistry this is far less often the case, partly owing, doubtless, to the nature of the subject. In both works the experiments are judiciously chosen, carefully described, and well illustrated, and in many cases strikingly original.

One criticism of principle may be made. Mr. Newth says: "In a text-book it is almost inevitable that in giving such directions as will lead a student on to the discovery of a fact, the fact itself shall be stated." He may be right in this; but if so, it appears to afford an argument against the use of such text-books in the laboratory at all, for, speaking generally, the most valuable exercise of all for the student is the study of his recorded observations, and the endeavour to deduce therefrom the property or law they demonstrate. Is not the getting up of a proposition of Euclid a smaller intellectual feat than the solution of a "rider"?

Especially does this principle of research appear to be applicable to the laws of elementary physics; but Mr. Watson apparently endorses Mr. Newth's view.

With this reservation, we cordially recommend both these volumes to the notice of teachers of elementary science. From the point of view taken, the work has been well done in both cases, and the books reflect credit alike on authors and publishers. C. H. D.

A Text-Book of the Science and Art of Bread-Making. By William Jago, F.I.C., F.C.S. Pp. 618. (London: Simpkin, Marshall, Hamilton, Kent, and Co., 1895.)

THE practical application of science to the arts and trades has been one of the most notable features of the present century, with the almost universal result of

raising the standard of the articles made, and at the same time of improving the prosperity and health of those who are employed in making them. The volume now before us shows the application of science to the art of bread-making, and a glance at its size and contents will at once show all those who are entering into this business that there is a very large amount of scientific knowledge required to equip a man efficiently to succeed in the keen competition of the present day.

The chemistry of the subject is very fully dealt with, with valuable suggestions for practical work; and we have also a chapter on bacteriology, in which the history of our present knowledge of fermentation is clearly given up to date. Fermentation is, of course, an important process in bread-making, and a chapter on technical researches in this subject is given. The use of the microscope is also pointed out in the examination of different starches, &c. In addition to these principles, which may be said to form the groundwork of the subject, the more practical side also finds a place, such as commercial testing of wheat and flours, different methods of baking, both by machinery and otherwise; and, lastly, there are a few paragraphs on adulterations and the methods for recognising them. Numerous good illustrations are scattered throughout the book. This work will doubtless appeal to all those connected with the business of bread-making, and we imagine it will also find a place on the book-shelves of many medical and other scientific men.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Koch's Gelatine Process for the Examination of Drinking Water.

DR. EDWARD FRANKLAND, in a discourse delivered at the Royal Institution on February 21 (see NATURE, April 30), paid a just tribute to the work of the late Dr. Angus Smith, for he stated that Dr. Koch's invention was first made known and practised in England in 1882 by Dr. Angus Smith.

On the other hand, Dr. Percy Frankland has put forward a claim, in his work on "Micro-organisms in Water" (page 119), that Koch's method was introduced into this country by himself—a claim reiterated in his evidence before the Royal Commission on Metropolitan Water Supply at Question 11099 (Prof. Dewar). "I believe you tell us that you were the first person in this country who adopted the Koch method, and applied it to the London Water Supply?" "Yes, that is so."

As I was scientific assistant to the late Dr. Angus Smith, and worked with him on Dr. Koch's gelatine method, I should like to state that not only was the method applied by Dr. Angus Smith to the London Water Supply in February 1883, but also to a variety of waters from different parts of the country. The results of Dr. Angus Smith's work are to be found in the second Report of the Local Government Board R.P.P. Act, 1876.

Ellerslie, Alderley Edge, May 6. FRANK SCUDDER.

I AM much indebted to Mr. Scudder for furnishing an opportunity for calling attention to a misapprehension which appears to exist in some quarters as to the time and manner in which Dr. Koch's method of water examination by the process of gelatine-plate-culture was introduced into this country, as but for his letter I should not have thought it worth while to discuss a matter which must be sufficiently well known to all who are really conversant with the development of bacteriological inquiry in Great Britain during the past fifteen years. In the first place, I would point out that in making the statements referred to by Mr. Scudder, I did so with the full cognisance of the late Dr. Angus Smith's work as published by him in his second Report to the Local Government Board, and in an article of his which appeared in the *Sanitary Record* in 1883. In this work I was so much interested that I at once, in the same year, set about applying the method described by Dr. Angus Smith to a number of the samples of London and other waters which were being subjected to analysis in my private house at the time. These experiments yielded, however, such indefinite and unintelligible results that I entirely abandoned Dr. Smith's process, and it was not until the summer of the following year (1884) that I became really acquainted with Koch's method of plate-cultivating bacteria through the now classical demonstrations given by Mr. Watson Cheyne at the Health Exhibition. It was this method of gelatine-plate-culture which I then immediately applied to the investigation of a number of problems connected with the bacterial purification of water by filtration, precipitation, &c., both on the laboratory and on the industrial scale, and the results of which I placed in the hands of the Royal Society in May 1885, in a paper entitled "The Removal of Micro-organisms from Water." It is this paper which I believe to be the first published account in this country of the application of what is now universally understood as "Koch's gelatine-plate-process" to the examination of water, and the first to contain numerical determinations of the bacteria present in a given volume of the various waters supplied to London. In the autumn of the same year (1885) I undertook, at the request of the late Sir Francis Bolton, then Water Examiner for the Metropolis, to make for the Local Government Board regular monthly examinations by this process of the various waters, both before and after filtration, supplied by the several London Water Companies, and the results of these were regularly published in the monthly reports issued by the Local Government Board.

That I do not stand alone in viewing Dr. Angus Smith's method and that of Dr. Koch as distinct, will be apparent from the following words, extracted from Dr. Smith's above-mentioned Report to the Local Government Board:—"I do not know, even now, if I employ the method which Dr. Koch would consider the best, but the book on the subject promised by himself and his coadjutor not having appeared, I consider myself liberty to proceed with my inquiries"; and in point of fact, if any competent bacteriologist will take the trouble to read Dr. Angus Smith's report, he will see that although both processes of course involve the use of gelatine, they are in many important respects widely divergent. In the first place, the medium employed by Dr. Angus Smith contained gelatine only, and was destitute of the nutrient constituents—meat-broth and peptone; so that the appearance of colonies in his process would thus partly depend upon the chemical composition of the water, a condition of things which tends to defeat the object in view, viz. the discovery of the living as distinguished from the dead and unorganised matter in the water. Indeed Dr. Angus Smith distinctly deprecates rendering the medium more nutritive, *e.g.* by the addition of sodium phosphate and sugar, which he employed in some of his experiments. On the other hand, one of the cardinal principles of Koch's method is the use of as highly nutrient a medium as possible, so as to render the cultivation results absolutely independent of the chemical composition of the water. Again, of fundamental importance in the Koch method is the cultivation in such a thin stratum of the solid medium that all parts of it shall be practically under identical conditions and plentifully supplied with oxygen. Dr. Angus Smith, on the other hand, cultivated in test-tubes eight inches in depth, and the disadvantage of this he appears to have himself realised, as he points out that the cultures of very impure waters suffer from want of oxygen in the depth, and thus lead to erroneous results. In fact I have failed to find in Dr. Angus Smith's publications any mention whatsoever of cultivation on plates or their equivalents in any shape or form, which I hold to be the essence of the process which bears the name of Koch, and to which modern bacteriology is so profoundly indebted. Without, therefore, in any way wishing to detract from the interest attaching to Dr. Angus Smith's independent investigations on the application of gelatine to water examination, it appears to me that as he seems not to have been acquainted with what is known and described in text-books as Koch's method of water examination, he cannot obviously be said to have introduced it into this country. Indeed, I cannot personally find any more justification for the statement that Dr. Angus Smith practised Koch's method of gelatine-plate-culture in 1882, than there would be for saying that Hero drove a steam locomotive in Alexandria more than a century before the Christian era.

PERCY F. FRANKLAND.

Mason College, Birmingham, May 12.

On the Action of Röntgen Rays and Ultra-violet Light on Electric Sparks.

IN NATURE of April 30, the writer of "Recent Work with Röntgen Rays" has not exactly described the results of our experiments, published in the *Rendiconti dell' Accademia dei Lincei.*

We had formerly found that the sparking distance between two electrodes, in a shunt-circuit on the discharge of an induction coil, which illuminates a Crookes' tube, is strongly diminished if the Röntgen rays sent from the tube fall upon the positive electrode. The phenomenon is very interesting, as it is the reverse of the phenomenon discovered by Hertz, in which the ultra-violet light acts on the sparking distance in lengthening it, when falling on the negative pole.

On subsequent experiments, we found that when the sparking distance was the same as that used with Röntgen rays, the ultra-violet light acted exactly in the same way, and the passive pole —so to say—was then the positive one.

So far we had succeeded in reversing the phenomenon discovered by Hertz, and further investigated by Wiedemann, Ebert, Elster and Geitel, and had shown the parallelism of the two radiations as to their impeditive action on the spark.

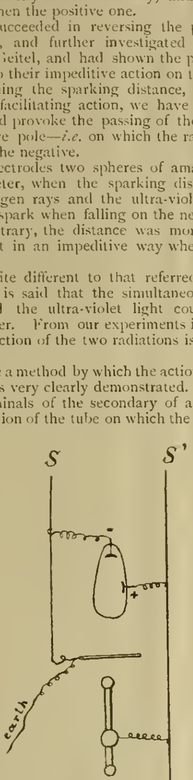
But on diminishing the sparking distance, when the ultra-violet light has a facilitating action, we have shown that the Röntgen rays would provoke the passing of the spark. In the last case the passive pole—*i.e.* on which the radiation must fall —is in both cases the negative.

So taking as electrodes two spheres of amalgamated brass, 52 mm. in diameter, when the sparking distance was below 30 mm., the Röntgen rays and the ultra-violet light provoke the passing of the spark when falling on the negative electrode. When, on the contrary, the distance was more than 30 mm., both radiations act in an impeditive way when falling on the positive pole.

This result is quite different to that referred to in the cited article, in which it is said that the simultaneous actions of the Röntgen rays and the ultra-violet light could be made to neutralise each other. From our experiments it follows, on the contrary, that the action of the two radiations is in every respect identical.

We will describe a method by which the action of the Röntgen rays on the spark is very clearly demonstrated.

S, S' are the terminals of the secondary of an induction coil. In front of the portion of the tube on which the kathode rays fall



s a thin aluminium plate 20 cm. square, in connection with the negative electrode of the Crookes' tube: whilst the positive is connected with a sphere so that the sparks between the plate and the sphere take place in the direction of propagation of the Röntgen rays, to which the aluminium plate is transparent. The plate is connected to the earth. With this apparatus the length of the spark can be made *four* times greater when the Röntgen rays are screened before falling on the aluminium plate. On diminishing the intensity of the current in the primary so as to conveniently shorten the sparking distance, the inverse phenomenon can be obtained, so that the spark does not pass when the Rontgen rays are screened.

Our present researches aim at the study of the alteration of the nature of the discharge when the spark is under the action of the Röntgen rays.

A. SELLA.
Q. MAJORANA.

Istituto fisico della Università di Roma, May 3.

Röntgen Ray Phenomena.

AT one of my demonstrations last week two tubes failed to act. They were both of the kind which depend for their action on a piece of platinum placed within, and from which after bombardment by kathode rays the Röntgen rays take origin. A glance at the tubes showed that owing to the unusual strength of spark the platinums within them were red-hot at the point of impact. Before the demonstration the tubes had been in good working order. I considered they had broken down, but, on returning home, tried them with the spark from my own apparatus, with which they had before answered well. I was somewhat astonished to find them giving off Röntgen rays rather more freely than when first tried. This tends to show that Röntgen rays are not given off by platinum heated above a certain temperature. I think this has already been suggested, but I have not seen it corroborated.

Following up the idea of reinforcing the effect of the Röntgen rays by placing a fluorescent screen under a sensitive film on celluloid, the celluloid side being next the screen to prevent "grain," and having tried screens of barium platino-cyanide, potassium platino-cyanide, calcium tungstate, natural scheelite, artificial scheelite (Edison's), fluor-spar and calcium fluoride, I find that potassium platino-cyanide and artificial scheelite alone produce any effect through celluloid. Barium platino-cyanide, placed underneath, gave no effect either in contact with the sensitive film itself or through celluloid, but the films were not sensitive to yellow, and this salt gives yellow fluorescence. The effect with potassium platino-cyanide was decidedly the best.

Chard, May 3. J. WILLIAM GIFFORD.

Alpenglühen.

AFTER the shadows of the lower mountains have swept up past the tops of the higher snow peaks, *i.e.* after the sun has set upon these last, and as the general light of the sky fades, the contrast between the illumination of the snow and of the sky usually increases. The westerly-facing snow peaks stand out against the darkened sky, and gradually change in tint. Very often the most noticeable change is to a clear greenish-white. But sometimes there is a period during which they have a faint rose or crimson glow. This is the true Alpenglühen; often confused by tourists with the ordinary rose-coloured illumination preceding the setting of the sun.

I see (NATURE, vol. liii. p. 588) that it has been suggested that this afterglow is due to what practically amounts to a second rising of the sun upon the high snow, owing to a peculiar arrangement of layers of hot and cold air in the atmosphere. This may be so; but it is rather a startling theory, and should be tested by observations from, say, the higher or lower observatories of Mont Blanc, simultaneously with observations of the Alpenglühen made from below anywhere to the west. A reappearance of the sun would be an interesting sight for the higher observer. In the meantime, my own observations of some twelve or thirteen summers would lead me to suggest the following explanation. In the first place, I do not think that the afterglow is nearly as vivid as an observer believes. To the eye, the stars "come out," and the moon becomes almost dazzling, as the general light of the sky fades; and both "fade" as day breaks.

Next, I noticed the following during five months of uninterrupted observations of sunsets in the plains of Argentina. On some fine evenings, there was left, as daylight faded, a vivid line or band (of uneven thickness) of intense crimson colour in the west. This was so strong and so well defined that it lit up the westerly face of the estancia with crimson, and actually threw a fairly sharp shadow of the horizontal gutter. Vertical poles, &c., had of course no shadow; the source was too long in a horizontal direction. This crimson streak did not appear always, by any means. The westerly sky itself often passed through various tints of a clear greenish-blue.

It seems to me that, considering the snow heights facing the

west, what has been pointed out concerning the fading of the rest of the sky, the comparative localisation of light and colour in the west, and the illusion as to brightness that occurs when the background fades, the phenomenon of Alpenglühen, and that of the greenish illumination so often seen, can be accounted for without the help of the startling hypothesis quoted.

But it would be more satisfactory if observations could be made from above. Would M. Vallot sacrifice himself and spend some nights up in the observatories that he directs?

R.N.E. College, Devonport. W. LARDEN.

The Positions of Retinal Images.

THE thanks of your psychological readers are due to Mrs. Ladd Franklin for having, in her letter published in your number of February 13, called attention to Schön's experiments, which, as she says, have been unaccountably overlooked. I have in consequence been repeating the experiment which Mrs. Franklin describes, but so far with purely negative results. Although some of the observers gave answers which might hastily have been interpreted as confirmations of Schön's illusion, a further analysis showed conclusively that no one on whom I have experimented, so far, perceived it.

Allow me to indicate one or two points in Mrs. Franklin's letter which seem to require elucidation. She writes as if the object looked at in the experiment "consists of a single bright point." But surely the point H in her diagram—the fixation point—was a bright point as well as O or O'? In Schön's experiments the apparent distance of O or O' was judged relatively to H (which was a stick of phosphorus), by the "stereoscopic (or pseudoscopic) effect," and his explanation of the illusion was that we (unconsciously) judge as if the image actually produced on the right retina had been produced on the left, and *vice versa*. The image on each retina consists of two bright points, but cannot strictly be called a "double image," since the bright points are produced by two distinct objects—by the phosphorus at H, and by the light proceeding from O' or O. If Schön's explanation is correct, then, supposing the light really proceeds from O', and when the ray O' r' is darkened appears to come from O, the observer ought to say the object appeared to be not merely as far off as H, but a *long way* behind it. Further, if the ray O' l' is darkened instead of O' r' there ought to be no illusion—he should say the object appears much nearer than H (*i.e.* still at O'); and if either ray is cut off altogether, he will have no reason for judging the object to be at O', but will probably judge it to be further back—where the source of light actually is. In my experiments, so far, none of the observers have made any distinction between cases where the ray O' r' was darkened and those where the ray O' l' was; but if either of them was darkened considerably, they answered just as they did when one of them was totally extinguished; judging the object to be about where the source of light actually was—which was about the same distance as the phosphorus mark H, and very much nearer than the point O would have been.

I hope to continue the experiments, if possible until I get a positive result, and should be glad therefore to hear some further details of Mrs. Franklin's experiments, especially with reference to the points I have brought forward, either privately or through your columns. EDWARD T. DIXON.

4 Cranmer Road, Cambridge, April 17.

Colour Variations in Ducks and Pigeons.

ABOUT a year ago you published a short article by Mr. Francis Galton (April 11, 1895, vol. li. p. 570), in which he urged the desirability of making careful records of all cases of "sports" (sudden variations in domesticated animals, &c. Two such sports having arisen recently under my own observation, one in ducks and one in pigeons, I write to place the facts before your readers.

(1) *Ducks.*—In January 1894, I bought in Beyrout market a drake of the common "Mallard" colours and four ducks, two of normal wild-duck colour, one pure white, and one black, splashed with white. From these ducks I raised, the same season, thirty-six ducklings; and, from eggs given by a friend, nine more. Concerning the latter, nothing need be said at present, except that their own mother was of a very dark, dingy brown, and the ducklings were nearly black in the down. Of the thirty-six ducklings hatched from my own ducks' eggs, twelve or thirteen (I neglected to note the exact number at the time) were different in colour from their olive-green brethren and from anything I had seen before, being of a beautiful pale fawn colour above, shading into canary-yellow beneath, with darker pencillings and shadings on the sides of the head and back, and with the normal, symmetrical series of three pairs of light marks on the upper surface, distributed just as in normal, olive-green ducklings. The entire set of these pale ducklings proved to be females, and their plumage, when adult, was a pretty yellowish or sandy buff colour, with darker shadings, due to a brown streak down the middle of each of the contour-feathers. The speculum on the wing gave mostly sky-blue reflections, instead of the usual metallic green of common ducks. Two only of the dozen (or thirteen) differed perceptibly from the others, being of *uniform* cinnamon-brown colour, with white throats.

Five of these pale ducks were kept and allowed to breed, viz. one cinnamon-brown and four yellow ones. In addition, my stock during the season of 1895 consisted of three of the original old ducks (one white, one black, and one normal); three normal-coloured young ducks related to the pale ones (*i.e.* same paternity, and presumably same maternity to some extent); and two ducks raised from the eggs given by my friend, as above mentioned, and therefore non-related to the others—in all thirteen ducks. Of drakes there were four—two of normal mallard colour (related, as above, to the pale ducks), and two own brothers to the dark ducks, these having green heads and beautifully-pencilled stone-grey bodies, with no brown on the breast and no white collar—a departure from typical drake-colouration which is normal (in Syria at least) to dark varieties.

From this stock of ducks I raised last spring sixty-two ducklings, of which nineteen were fawn-coloured in the down. One of these died very young. Of the remainder, fourteen were females and four males. All were sandy-buff, none cinnamon-brown; but one—a female—was a shade or two darker than the rest, and when adult showed no metallic colours on the speculum, agreeing in this respect with the dark ducks of alien parentage.

Of greatest interest to me was the question: What will the "yellow" drakes be like when adult? Time has answered as follows: Head and neck, soft *coffee brown*, with obscure greenish reflections in some lights; narrow white collar; chestnut-brown breast, similar to mallard; upper tail-coverts (including curled feathers), and under-tail coverts, chocolate-brown; the rest delicate cream colour, with fine transverse pencillings on back and sides, similar to those on the mallard, but paler and less distinct: the whole effect very pleasing.

Of course all this may be familiar enough to some people, but it is quite new to me, and no mention of such drakes is made by Darwin in "Animals and Plants," nor by any other writer whose works I have been able to consult. Whether atavism has anything to do with the matter, I cannot say, as the parentage of my original stock is entirely unknown; but I am accustomed to notice very carefully all the ducks I see about town and the surrounding country, and am sure I have never come across any such during an experience of about twenty-five years. In any case, it is interesting to note that the new variety was far from being "swamped" by the inevitable crossing with its parent form.

(2) *Pigeons.*—In 1894 I procured a pair of birds of a variety known to Arab fanciers as black *Urjani* (or *Shamandarûzi*). These are largish pigeons, wholly black, with two "red" (*i.e.* bright reddish brown) bars on each wing, corresponding to the black bars on normal "blue" pigeons. The pair were unrelated, the male coming from Hums, the female from Damascus. The variety is scarce in Beyrout, and is valued more or less by all Syrian fanciers, who breed it with some care; and it habitually breeds true. My birds produced during the season of 1895 ten young ones: six (3 ♂, 3 ♀) quite normal in colour; one (♀) slightly mottled on the shoulders with brown and a very little white; and three (all ♀), which in the nest plumage were uniform *light red*. (I had not a red bird in the loft—scarcely a red feather, aside from the red bars of the *Urjanis* themselves, so there was no question of illegitimate paternity.) But, strange to relate, when these red birds moulted, nine-tenths or more of their red feathers were replaced by *pure white*, so that their adult plumage may be described thus: *white* birds with red neck, abdomen red mottled with white, a very few red feathers scattered over back and shoulders; no trace of red bars.

Careful inquiry among Arab fanciers having personal experience of the breed in question, elicited the following

information. Black *Urjanis* usually breed true; when they fail to do so, the progeny is generally a sport of a particular kind called *dijji*, uniformly red when young, more or less mottled with white when adult. These *dijjis* are apt to "throw back," and in turn produce good *Urjanis*.

One of my own mottled birds (*dijji*) remains in my possession, and is now mated to an *Urjani*—an own brother. The pair has produced this spring four young: three *dijjis*, just like the mother, and one partial reversion to the *Urjani* form, being dark-chequered blue, with red bars on the wings. The original parent pair of *Urjanis* have also raised four squabs this season—three normal and one *dijji*; sexes not yet determined. I state these facts without comment; but would be glad to know whether fanciers in England or elsewhere have observed anything quite as striking in the way of colour-variation.

W. T. VAN DYCK.

Beyrout, Syria.

Dependence of the Colour of Solutions on the Nature of the Solvent.

IT is a well-known fact that the colour exhibited by one and the same body in solution depends more or less on the nature of the solvent. In some cases this phenomenon can be satisfactorily accounted for by electrolytic dissociation, but in the majority of cases hitherto examined this explanation is not admissible. Perhaps the most striking of these is that of iodine, the solutions of which are coloured variously violet, blue, brown, and yellow. The hypothesis has been put forward that the variation in absorption might be due to the formation of molecular aggregates of variable complexity; but this, at least in the case of iodine, has been rendered very improbable by the recent researches of Beckmann and others. Nor does the hypothesis that the variation may be due to a varying degree of combination with the solvent seem much more promising.

If, now, absorption be a case of electrical resonance, should one not expect a relation between the absorption of the dissolved body and the physical properties of the solvent, sufficient to account for the observed variations? That such a relation should exist, seems possible from the following rough considerations.

The period of vibration of an electric oscillator is, in the usual notation,

$$T = 2\pi\sqrt{LC},$$

where L = self-induction, and C = capacity. But now:—

$$LC = gK\mu,$$

where g is a geometrical factor and K and μ are the dielectric constant and permeability of the surrounding medium. Also $n^2 = K\mu$, where n is the index of refraction of the medium for very long waves, whence it follows that

$$T = 2\pi n\sqrt{g},$$

which means that the principal absorption-band should travel towards the red end of the spectrum as the index of refraction of the solvent increases. This result is identical with the general qualitative law enunciated many years ago by Kundt, on the basis of experimental data. There are, it is true, various breaks in the parallelism; still this mode of viewing the question seems to offer more possibilities than the others.

F. G. DONNAN.

Holywood, Belfast.

Hatching Lizards' Eggs.

CAN any of your readers suggest a way to hatch lizards' eggs? I have had a pair of bright-green lizards (I think they came from Italy) in a glass vivarium in a very sunny window for two years and a half. Last year, on May 19, the female laid eleven eggs. I left them exactly as the mother laid them, and after about three weeks I opened one and found the rudiments of a young lizard; but the other eggs never came to anything. I should like to rear them this year if it is possible.

H. A. ROSS.

Trevean, Penzance.

THE DIFFUSION OF METALS.

IT is now quite usual to think of alloys as being solid solutions and to recognise that the atoms of solid metals are in active movement. That this must be the case, is revealed by the passage of metals to allotropic modifications in which the physical properties differ widely from those of the same metals in their normal state. It is well, therefore, that we should remember how much was done for us thirty years ago by Matthiessen in framing such views, and by Graham in showing that solid metals are true solvents for gases which move and diffuse freely in them, sometimes to reappear with gaseous elasticity.

The experimental portion of the latter work, Graham entrusted to me, and my hope that I should be able to extend his work on the diffusion of salts, to liquid and solid metals, has been somewhat tardily realised by the delivery in the present year of the "Bakerian Lecture" of the Royal Society, of which the following is a brief abstract.

PART I.—*Diffusion of Molten Metals.*

In the first part of it allusion is made to some earlier experiments of my own conducted in 1883 on the diffusion of gold, silver, and platinum in molten lead. It is strange that although the action of osmotic pressure in lowering the freezing point of metals has been carefully examined, very little attention has been devoted to the measurement, or even to the consideration, of the molecular movements which enable two or more metals to form a truly homogeneous fluid mass. The absence of direct experiments on the diffusion of molten metals is probably explained by the want of a sufficiently accurate method. Ostwald has stated, moreover, with reference to the diffusion of salts, that "to make accurate experiments in diffusion is one of the most difficult problems in practical physics," and the difficulties are obviously increased when molten metals diffusing into each other take the place of salts diffusing into water.

The continuation of the research was mainly due to the interest Lord Kelvin had always taken in the experiments. The want of a ready method for the measurement of comparatively high temperatures, which led to the abandonment of the earlier work, was overcome when the recording pyrometer was devised, and the use of thermo-junctions in connection with this instrument rendered it possible to measure and record the temperature at which diffusion occurred. Thermo-junctions were placed in three or more positions in either a bath of fluid metal or an oven carefully kept hotter at the top than at the bottom. In the bath or oven, tubes filled with lead were placed, and in this lead, gold, or a rich alloy of gold, or of the metal under examination, was allowed to diffuse upwards against gravity. The amount of metal diffusing in a given time was ascertained by allowing the lead in the tubes to solidify; the solid metal was then cut into sections, and the amount of metal in the respective sections determined by analysis.

The movement in linear diffusion is expressed, in accordance with Fick's law, by the differential equation

$$\frac{dv}{dt} = k\frac{d^2v}{dx^2}$$

In this equation x represents distance in the direction in which diffusion takes place, v is the degree of concentration of the diffusing metal, and t is the time; k is the diffusion constant, that is, the number which expresses the quantity of the metal in grams diffusing through unit area (1 sq. cm.) in unit time (one day) when unit difference of concentration (in grams per c.c.) is maintained between the two sides of a layer 1 cm. thick. The experiments described in the Bakerian Lecture showed that metals diffuse in one another just as salts do in water, and the results were ultimately calculated by the aid of tables prepared by Stefan for the calculation of Graham's experiments on the diffusion of salts, special tables being calculated by one of my students, Mr. A. Stansfield, in connection with this research.

The necessary precautions to be observed and the corrections to be made were described at length and the

values for k—the diffusivity of certain metals in lead, tin, bismuth and mercury, given in sq. cm. per day, are as follows:—

		k
Gold in lead	... ...	3·19 at 550°
,, bismuth	... ...	4·52 ,,
,, tin...	... ...	4·65 ,,
Silver in tin	... ...	4·14 ,,
Lead in tin	... ...	3·18 ,,
Rhodium in lead	... ...	3·04 ,,
Platinum in lead	... ...	1·69 at 490°
Gold in lead	... ...	3·03 ,,
Gold in mercury	... ...	0·72 at 11°

In order to afford a term of comparison, it may be stated that the diffusivity of chloride of sodium in water at 18° is 1·04.

It is at present too soon to draw any conclusion as to the evidence which the results afford respecting the molecular constitution of metals, but it is evident that they will be of value in this connection, because, with the exception of the gases, they present the simplest possible case which can occur—the diffusion of one element into another. Thus the relatively slow rate of diffusion of platinum as compared with gold, points to its having a more complex molecule than the latter.

It is very difficult within the limits of this brief abstract to show that molten metals actually pass into each other by diffusion. The following method will, however, serve to give a rough qualitative demonstration that such is the case. A white sheet of card, B, is, as Fig. 1 shows, mounted on a frame, and by means of the gearing C C′ can be raised or lowered at a definite rate, which can be maintained by the aid of a metronome. The diffusion cell is shown at A. It consists of a clay tube about 30 mm. long, heated from its upper part so that the top portion of the tube is hotter than the lower portion. This tube is filled with molten lead, and at the bottom of the lead, is a layer of a lead-gold alloy rich in gold. A sample of lead may be withdrawn from the tube at the beginning of a lecture and

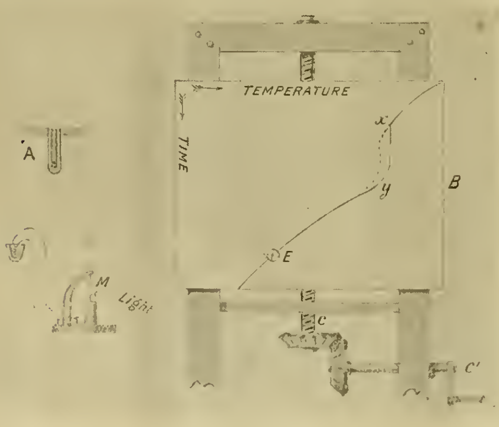


FIG. 1

set aside, while a second sample of lead may be removed at the end of an hour, by which time gold will have diffused into the upper layers of lead, and consequently this second sample will be auriferous. Other experiments have shown that in this case convection currents do not complicate the result.

The proof that gold had diffused into lead can then be afforded by the fact that the point of solidification of the second portion of lead is, owing to the presence of gold in it, lower than that of the first portion, and this is shown to be the case in the following way. The first sample of lead is placed in a small crucible, D, and a

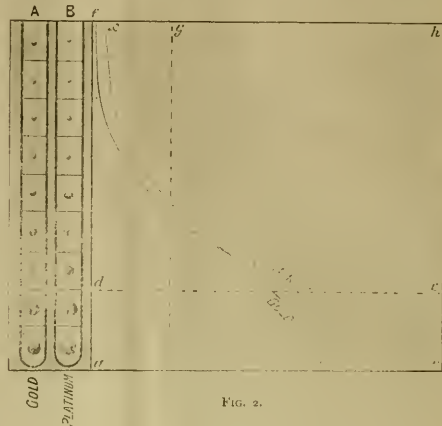


FIG. 2.

protected thermo-junction is immersed in the lead when it is fluid. The spot of light E from the mirror M, of the galvanometer connected with the thermo-junction is allowed to fall on the movable screen, and as the lead cools down the spot of light traverses the screen from right to left. The consecutive positions occupied by the centre of this spot of light are marked by hand with a stroke of charcoal. During the solidification of the metal the spot of light remains in one position, and consequently the portion of the curve which represents the solidification of the metal is the vertical line x, y. If the second sample of lead be treated in exactly the same way, and its "cooling curve" traced, it will be seen that the freezing point is lowered, and a demonstration is thus afforded that diffusion of gold has occurred in the lead contained in the tube A.

The results of the diffusion of platinum and gold in fluid lead during twenty-four hours is shown diagrammatically in Fig. 2. The lead was placed in tubes which were arranged side by side in the oven, to which reference has been made. The columns A B represent the actual length and diameter of the columns of fluid lead. The spheres, which are drawn to the left of the diagram, are slightly smaller than the buttons of gold and of platinum extracted from the several sections, shown by horizontal lines, into which the columns of lead were divided after the metal had been allowed to solidify. The curves represent the respective diffusivity of gold and of platinum. The vertical ordinate represents the *distance* in the direction in which diffusion takes place, and the horizontal ordinates *concentration* of the diffusing metal. Each of the metals gold and platinum which diffused into the fluid column of lead occupied in the form of an alloy rich in lead, the length a d, of the

tube, and in both cases, the initial concentration of the alloy, denoted by *a c*, from which diffusion proceeded, was the same, so that the area, *a c e d*, represents the total amount of gold or platinum employed in the experiment, the whole quantity of either metal being initially below the line *d e*. The final state of complete diffusion would be represented by the area *a b g f*, which is the same as *a c e d*, since the quantity of gold or of platinum remains unaltered. In the same manner the area *a y x f*, would represent the distributions of the gold at the end of the experiment, and consequently in experiments which have lasted for equal times, the nearer the curve approximates to the line *b*, *g*, the more rapid is the diffusion of the metal it represents. It will be evident from the distribution of the spheres of gold and platinum that diffusion can be accurately measured in molten metals.

PART II.—*Diffusion of Solid Metals.*

The second part of the investigation was devoted to the consideration of the diffusion of solid metals. Much of the evidence is historical, for there has long been a prevalent belief that diffusion can take place in solids, and the practice in conducting important industrial operations supports this view. In this connection two truly venerable "cementation" processes may be cited. The object in the first of these is the removal of silver from a solid gold-silver alloy, while the second is employed in steel making by the carburization of solid iron. In both of these processes, however, a gas may intervene, though the carburization of iron by the diamond, which, in 1889, I effected *in vacuo*, suggests that if a gas does intervene in the latter case, its quantity must be very minute. In connection with the mobility of various elements in iron the work of Colson, of Osmond, and of Moissan must be carefully kept in view.

The electro-deposition of metals also affords evidence of the interpenetration of metals. I observed in 1887 that an electro-deposit of iron on a clean copper plate will adhere so firmly to it that when the metals are severed by force, a copper film is actually stripped from the copper plate and remains on the iron, thus affording clear evidence of the interpenetration of metals at the ordinary temperature, and this interpenetration of copper and iron will take place through an intervening film of nickel.

My friend Dr. George Gore has given me the following interesting reference to the penetration of gold and platinum at a temperature below redness, which is recorded in "Weldon's Register" for July 1863 by Edward Sonstadt, who states that he gilded a platinum crucible "inside and out . . . but no sooner was the platinum warmed than it began to change colour, and before the crucible attained visible redness not a vestige of the gilding remained."

This is interesting in connection with the earlier observation of Faraday and Stodart, who in 1820 showed that platinum will alloy with steel at a temperature at which even the steel is not melted, and they expressed their interest in the formation of alloys by cementation, that is by the union of solid metals.

The remarkable view expressed by Graham, in 1863, that the "three conditions of matter (liquid, solid, and gaseous) probably always exist in every liquid or solid substance, but that one predominates over the other," affords ground for the anticipation that metals will diffuse into each other at temperatures far below their melting points. The important work by Spring, in 1886, on the lead-tin alloys, showed that they retain a certain amount of molecular activity after they become solid, and special importance will always be connected with the proof afforded by him (1882), that alloys may be formed either by the strong compression of the finely divided constituent metals at the ordinary temperature, or (1894) by the union of solid masses of metal compressed together at temperatures which varied from 180° in the case of lead and tin, to 400° in the case of copper and zinc; tin melting at 227° and zinc at 415°.

Early evidence as to the volatilisation of solid metals may be traced to the expression of Robert Boyle's belief, that even such solid bodies as glass and gold might respectively "have their little atmospheres, and might in time lose their weight," and Merget's experiment on the evaporation of frozen mercury is specially interesting in relation to Gay-Lussac's well-known discovery that the vapours emitted by ice and water both at 0° C., are of exactly equal tension. Demarçay's experiment on the volatilisation of metals *in vacuo* at comparatively low temperatures is, moreover, connected with the evidence afforded by Spring (1894), that the interpenetration of two metals at a temperature below the melting point of the more fusible of the two is preceded by volatilisation.

It is well to remember, however, that interesting as the results of the earlier experiments are, as affording evidence of molecular interpenetration, they do not, for the purpose of measuring diffusivity, come within the prevailing conditions in the ordinary diffusion of liquids, in which the diffusing substance is usually in the presence of a large excess of the solvent, a condition which was fully maintained in the experiments on the diffusion of liquid metals described in the first part of the Bakerian Lecture. Van 't Hoff has made it highly probable that the osmotic pressure of substances existing in a *solid solution* is analogous to that in liquid solutions, and obeys the same laws; and it is probable that the behaviour of a solid mixture, like that of a liquid mixture, would be greatly simplified if the solid solution were very dilute.

The experiments on the diffusion of solid metals are of the same nature as in the case of fluid metals, except that the gold, which was the metal chosen for examination, was placed at the bottom of a solid cylinder of lead instead of a fluid one.

In the first series of experiments, cylinders of lead, 70 mm. long, with either gold, or a rich alloy of gold and lead at their base, were maintained at a temperature of 251° (which is 75° below the melting point of lead) for thirty-one days. At the end of this period the solid lead was cut into sections, and the amount of gold which had diffused into each of them was determined in the usual way. Other experiments were made, in which the lead was maintained at 200°, and at various lower temperatures down to that of the laboratory. The following are the results in sq. cm. per day:—

				k
Diffusivity of gold in	fluid	lead at	550	... 3·19
,,	solid	,,	251	... 0·03
,,	,,	,,	200	... 0·007
,,	,,	,,	165	... 0·004
,,	,,	,,	100	... 0·00002

The experiments at the ordinary temperature are still in progress, but there is evidence that slow diffusion of gold in lead occurs at the ordinary temperature. If clean surfaces of lead and gold are held together *in vacuo* at a temperature of only 40° for four days, they will unite firmly, and can only be separated by the application of a load equal to one-third of the breaking strain of lead itself. The nature of welding, however, remains to be investigated, as there is probably interlocking of molecules and atoms, which precedes true diffusion. It may be considered remarkable that gold placed at the bottom of a cylinder of lead, 70 mm. long (which is to all appearance solid), will diffuse to the top in notable quantities at the end of three days. At 100° the diffusivity of gold in solid lead can readily be measured, though its diffusivity is only 1/100,000 of that in fluid lead at a temperature of 500°, and experiments which are still in progress show that the diffusivity of solid gold in solid silver, or copper, at 800° is of the same order as that of gold in solid lead at 100°.

I trust, therefore, that the experiments described in the Bakerian Lecture will show that the diffusion can readily be measured in solid metals, and that they will carry one step further the work of Graham.

W. C. ROBERTS-AUSTEN.

BOOKS ON BIRDS.[1]

THE issue of works on ornithology continues in an unbroken stream. There can be little doubt that since the arrangement of the birds in the National Museum in South Kensington, in their natural attitudes and surroundings, was adopted—a system largely followed in many of our provincial museums—there has been a distinct increase in the interest taken in natural history, and, as might be expected from the amount of knowledge as to their life and habits which these groups convey, the study of birds has largely increased. The constant demand for work after work on the limited subject of British birds is very remarkable, and is to some extent a measure of the growing interest in this branch of science.

With the second volume, which has lately appeared, Dr. R. Bowdler Sharpe has completed his "Handbook to the Birds of Great Britain" in Allen's Naturalist's Library, of which he is the editor. His knowledge of the subject of which he treats is admittedly unrivalled, while the thorough manner in which he performs all his work—though vast in amount—is so well known, that his name, as editor and author, is sufficient guarantee for the value and excellence of these two volumes. All that is essential to be known in the life-history of British birds is related shortly yet fully, in clear, popular language. This work forms a concise monograph of our native birds; indeed, no better or more authoritative work on the subject has yet been published. It is illustrated by numerous coloured full-page plates, the bulk of them the resuscitated drawings of Lizars from Jardine's Library. As has been often already pointed out, and pressed upon the attention of the publishers in regard to other volumes of this series, those plates are quite unworthy of the text. In the preface to the second volume the author replies to the critics who have attacked his method of nomenclature adopted in this and other volumes of the Library, the result of which is that certain species come to be designated by a duplication of their generic and specific names. Dr. Sharpe appears to us to have adopted the only logical course open to him, and his reply would seem to be unanswerable. "Thus if Linnæus," he says, "called the Partridge *Tetrao perdix*, the name *perdix* ought to be retained at all costs for the species. When *Perdix* was taken in a generic sense and the species was called *Perdix cinerea*, I contend that it ought never to have been allowed, and if in restoring the Linnæan specific name of *perdix*, it results that the oldest generic name is also *Perdix*, and the species has to be called *Perdix perdix* (L.), I can only say I am sorry, but it cannot be helped."

In Mr. Hudson's "British Birds" a brief account is given of the appearance, language and life-habits of all the birds that reside permanently or for a portion of each year within the limits of the British islands. The descriptive accounts of the various species are shorter, less technical and precise, but not less accurate than those in Dr. Sharpe's "Handbook." On the other hand, our author trusts that his work has the merit of simplicity, as it is intended for the general reader and, more especially, for the young. The species alone are described, the family and generic characters being omitted, as there was not space to make the book, "at the same time, a technical and a popular one." Like all that comes from Mr. Hudson's pen on this subject, the present volume is sympathetically and attractively written. It is illustrated by eight chromolithograph plates from original drawings by A. Thorburn, in addition to eight full-page plates and one hundred figures in black-and-white, from drawings by G. E. Lodge, prepared for this work, the whole of which are exquisitely reproduced. Altogether the book is to be very highly recommended. It is prefaced by a chapter on structure and classification by so competent an anatomist as Mr. F. E. Beddard, F.R.S. His contribution, however, though very clear and condensed, is, we fear, somewhat above the heads of the bulk of the young readers for whom Mr. Hudson's pages have been written. On p. 17, he remarks, with reference to the fore-limb in *Dinornis* that no trace of a wing has been so far discovered. In 1892 a scapulo-coracoid, with a distinct glenoid cavity, was figured in NATURE (vol. xlv. p. 257), indicating the presence of a humerus, which is surely at least a "trace" of a wing.

In the "Wild Fowl and Sea-Fowl of Great Britain," a "Son of the Marshes" depicts the haunts rather than the habits of the birds of our estuaries and fen-lands. His volume is more a collection of shooting sketches than a serious contribution to ornithology, notwithstanding the short technical descriptions, at the conclusion of each chapter, of the several species of the group to which the chapter is devoted. The author has given us during many years numerous delightful sketches of marsh-land life at every season, and under all conditions of sky and temperature; but we have had his message so often now, that it has begun to lose much of its freshness and flavour. In this latest delivery we cannot resist the impression that we have heard all he tells us before, and said even better than here. Many of his pages leave with the reader the irritating suspicion of having been elaborated with toil, and the matter beaten out to cover an allotted space. The numerous quotations from all sorts and conditions of marsh-folk, "coy" men, net-setters, and wild-fowlers, in which we fail, through obtuseness probably, to perceive anything humorous, quaint or original, might have been largely curtailed with advantage to the narrative. J. A. Owen, who edits the volume, has allowed to escape detection such unorthodox expressions as "to flight" and "flighting birds," as also the use of that most objectionable term "scientist," to indicate the professed man of science. The volume has numerous excellent full-page black-and-white illustrations by Bryan Hook.

[1] "A Handbook to the Birds of Great Britain." By R. Bowdler Sharpe, LL.D. Vol. i. 1894. Pp. xxii + 342. Vol. ii. 1895. Pp. xi + 308. (London: W. H. Allen and Co., Ltd.).

"British Birds." By W. H. Hudson, C.M.Z.S. With a Chapter on Structure and Classification, by Frank E. Beddard, F.R.S. Pp. xviii + 363. (London and New York: Longmans, Green, and Co., 1895.)

"The Wild-Fowl and Sea-Fowl of Great Britain." By a "Son of the Marshes." Edited by J. A. Owen. With Illustrations by Bryan Hook. Pp. 326. (London: Chapman and Hall, Ltd., 1895.)

"Birds from Moidart and Elsewhere; drawn from Nature." By Mrs. Hugh Blackburn. Pp. viii + 191. (Edinburgh: David Douglas, 1895.)

"The Birds of Berwickshire, with Remarks on their Local Distribution, Migration, and Habits, and also on the Folk-lore Proverbs, Popular Rhymes and Sayings connected with them. By George Muirhead, F.R.S.E. In two volumes. Vol. i. 1889. Pp. xxvi + 334. Vol. ii. 1895. Pp. xii + 390. (Edinburgh: David Douglas.)

"North American Shore Birds: a History of the Snipes, Sandpipers, Plovers, and their Allies." By Daniel Giraud Elliot, F.R.S.E. With seventy-four plates. Pp. viii + 268. (London: Suckling and Galloway. New York: Francis P. Harper, 1895.)

"The Birds of Ontario, being a Concise Account of every Species of Bird known to have been found in Ontario, with a description of their Nests and Eggs, and Instructions for Collecting Birds and Preparing and Preserving Skins, and Directions how to form a Collection of Eggs." By Thomas McIlwraith. 2nd edition. Pp. ix + 426. (London: T. Fisher Unwin; Toronto: William Briggs, 1894.)

"Birdcraft; a Field-book of Two Hundred Song, Game, and Water Birds." By Mabel Osgood Wright. With full-page plates. Pp. xvi + 317. (New York and London: Macmillan and Co., 1895.)

"Photographs of the Life-History Groups of Birds in the Grosvenor Museum, Chester." Prepared by Mr. R. Newstead, Curator; photographed by G. W. Webster. 1895.

"The Royal Natural History." Edited by Richard Lydekker, B.A., F.R.S. Vol. iv. Birds (chaps. viii.-xxi.). Pp. xv + 583. (London: Frederick Warne and Co., 1895.)

"The Fauna of British India, including Ceylon and Burma." Published der the authority of the Secretary uf State for India in Council. Edited by W. T. Blanford. Birds. Vol. iii. By W. T. Blanford, F.R.S. p. xiv + 450. (London: Taylor and Francis; Calcutta and Bombay: hacker and Co.; Berlin: Friedländer, 1895.)

We next come to notice two local faunas. The first of which is Mrs. Hugh Blackburn's "Birds from Moidart and Elsewhere." The authoress is a well-known artist, and the volume before us is not so much a systematic avi-fauna of the region in which she resides, as a series of drawings from nature, all of them artistic, vigorous, and true to life, of such birds as she has known personally, "to which are added," as she tells us in the preface, "simply, and I trust truthfully, a few observations which I have had the opportunity of making on their life and habits." Her sketch of the young and callow cuckoo ejecting the rightful meadow pipits from their nest, is the original illustration of this most interesting fact, which, first made known by Henry Jenner in 1788, and long rejected as apocryphal, was in 1871 re-described, and still more fully established in 1872, when it was sketched from actual observation by Mrs. Hugh Blackburn. Her plates illustrating the habits of many species not to be observed everywhere, such as "Solan-geese fishing," "Cormorants feeding their young," "Osprey carrying a fish," are of real scientific interest and value. So also are the sketches of the nestlings of several birds whose breeding-places are chosen in out-of-the-way corners, whither our artist seems to have followed them. Mrs. Blackburn states the interesting facts that in 1856 there were no starlings in Moidart, where they are now plentiful, and not for many years after were there any common sparrows. On the advent of the latter, however, the yellow-hammers, "which used to be very common," began to decrease rapidly. She records also, on the faith of a correspondent, that a nightingale was heard for three weeks, and also seen during the month of June 1889, "at Achnacary," which, if the observation can be depended on, is a far cry beyond its usual northern limit. On turning to Dr. Sharpe's and Mr. Hudson's volumes, noticed above, we find it recorded that in Scotland and Ireland the nightingale is unknown. (!)

"The Birds of Berwickshire," by Mr. George Muirhead, of which the first volume was published in 1889, and the second in 1895, contains a full account of every bird known to occur in that extensive shire. The work, published by David Douglas, of Edinburgh, is printed on special paper, and on its pages space and variety of type have been generously lavished. Each bird's history is concluded by a charming pen-and-ink etching of its nest, of one of its favourite haunts, or of some interesting, historical, or beautiful Berwickshire "bit," which has more or less direct reference to the subject of the chapter. There are, in addition, several full-page etchings by Scottish Academicians, and an excellent map of the county. Altogether, therefore, no expense has been spared (as is wont with the publishing house of David Douglas) to produce a work worthy of its predecessors in their sumptuous Natural History Library. And although these volumes can but record few new facts about the birds described in them except what is of local distributional interest, they are full of folk-lore, proverbs, popular rhymes and sayings about them, which must ensure the book being greedily desired as a prized addition to his volumes *de luxe*, not only by every lover of birds and their haunts, but by all who treasure dainty books.

The three volumes next on our list follow much the same lines as those above noticed, only they deal with American instead of British birds. "North American Shore Birds," by D. G. Elliott, who is well known by his numerous magnificent scientific monographs, "is a popular work and in no sense a scientific treatise," as the preface informs us. Its object is to enable the sportsman and those who love to study birds in their haunts, to know and recognise those they shoot or observe on the wing. "The accounts of their habits have been written, to the best of the author's ability, in language 'understanded of the people.'" Mr. Elliott will, we have no doubt, be fully successful in his object, for his book cannot fail to satisfy both those classes; and we are confident it will be their frequent companion, both "in the open" and in the study. The volume is not a mere compilation, for the record of the habits of most of the species are derived from the author's own experience in the many hunting excursions he has undertaken from arctic Alaska all over the North-American continent, and as far south as Rio de Janeiro. Nearly every species described in the book is illustrated by a full-page plate in black-and-white from drawings of great beauty by Edwin Sheppard, of the Academy of Sciences of Philadelphia, "an artist possessing exceptional talent for portraying birds and bird-life."

Mr. McIlwraith, in his "Birds of Ontario," enumerates 317 species, which he believes to be the complete tale of the birds occurring in the province of his domicile. A short, but sufficient, account is given of their plumage, their range, their distribution in Ontario, and, as they are nearly all migatory, of where they spend the breeding season, as well as of their nests and eggs. In the introduction full instructions are provided for the young collector how to obtain and preserve his specimens.

In "Birdcraft," Mabel Osgood Wright describes and illustrates two hundred song, game, and water birds of North America. Her book is written for the young, in whom she wishes to encourage the study of "the living bird in his love songs, his house-building instincts, and his migrations," to discourage in them the "greed of possession" of the skin, nest and eggs of her feathered friends, and to enable them to identify and properly name the species they may observe in their excursions. To her disciples—may they be many!—she gives this excellent advice: "Take with you three things, a keen eye, a quick ear, and loving patience"; but leave to "the practised hand of science," "the gun that silences the bird-voice, and the looting of nests." The authoress, who is herself, apparently, a keen and sympathetic observer of nature, believes that all the lover of birds wishes to know of their forms closer at hand, on his return from the field, should be sought for, and will be found, in those "great picture-books"—the museums. "Birdcraft" should form an excellent guide to the young American field-naturalist. Unfortunately the chromo-lithograph plates, on which eight to ten species, varying greatly in colour and size, are crowded, leave much to be desired. A "key to the birds" is provided at the end of the book, by which (*a*) land birds, (*b*) birds of prey, and (*c*) game, shore and water birds may be identified by their predominant colours.

The "Life-History Groups of Birds" in the Grosvenor Museum, Chester, most of which have been mounted by the Curator, Mr. Newstead, have been photographed "in life-like attitudes" with the "natural surroundings proper to the particular specimens," by Mr. G. W. Webster of the same city, and offered to the public in a handsome volume. It is hoped by the authors that these pictures "will appeal to curators and museum authorities, to all lovers of birds and nature, and to artists." To curators of museums they may on occasion afford suggestions; but as they are a class who strongly object to imitate slavishly the methods of even the greatest of their colleagues, they will probably prefer to seek inspiration from the same source as Mr. Newstead. To artists and lovers of birds we have no doubt these platinotypes will afford a great deal of pleasure, and in the case of the former they will be extremely useful as models. The weight of the volume and its high price (necessary from the costliness of its get-up) will, however, we fear, militate against a wide circulation, and certainly against its use for frequent and comfortable reference.

The fourth volume of the "Royal Natural History," edited by R. Lydekker, F.R.S., completes the account of

the birds. The contributors on this occasion are Dr. Bowdler Sharpe, Mr. Ogilvie-Grant, and the editor, whose names are sufficient sponsors that the present volume is in no way behind its predecessors, which every section of the press has been unanimous in praising on account of the scientific excellence of the text, and the beauty of the illustrations. As a "Natural History," presenting a popular and comprehensive survey of the subject, the "Royal" is unsurpassed.

The now well-known two first volumes of the "Birds" in the valuable "Fauna of British India," which the India Office has been so well advised in publishing, were written by Mr. Oates. The present volume has been prepared by the editor of the series, Dr. W. T. Blanford, "who," as he says, "has endeavoured to keep the [continuation of the] work uniform in general plan, and to render the change in authorship as little conspicuous as possible." Everywhere throughout the book, the same care and pains that were manifest in Mr. Oates' two volumes are evident in the third before us. Thanks to Hume—the value or extent of whose unsurpassed gift to the nation has yet hardly begun to be appreciated as it must one day be never before has material for an avi-fauna of India, approaching in its richness been anywhere brought together as that now conserved in the British Museum. The amount of comparison and original investigation demanded, consequently, of the authors in compiling for the first time since this collection has been available, the bird-fauna of our Eastern empire, has been enormously extended, as well as facilitated. Although Mr. Oates, on being prevented from completing the work he commenced, by his recall to official duty in India, handed over to Dr. Blanford, on his departure, the notes he had prepared for its continuation (which have been "of very great service," as the author admits), yet the more arduous part of the work had still to be done. That this task, slow, full of drudgery, and testing all the penetration and discrimination of the ornithologist, has been most conscientiously fulfilled, is evident on every page, and with a result in all respects on which Dr. Blanford is to be congratulated.

It had been intended to complete the "Birds" and (with that section) the Vertebrata of India with the present volume; but as the work progressed, it "became evident that the proposed third volume would be of inconvenient size," and it was, therefore, decided to divide it into the present and a concluding volume, which, it is stated, is now in an advanced state of preparation. The volume under notice includes the *Eurylæmi*, *Pici*, *Zygodactyli*, *Anisodactyli*, *Macrochires*, *Coccyges*, *Psittaci*, *Striges*, and *Accipitres*. The different orders are distinguished chiefly by their anatomical characters. The *Striges* are rightly kept distinct from the *Accipitres*; but the *Pandionidæ* are included within its limits. We should rather have seen them constituted a distinct order, *Pandiones*. It is with satisfaction we note that the publication of the final volume will not be long delayed.

NOTES.

THE long list of birthday honours contains the names of a few men distinguished for their scientific attainments. Prof. Max Müller is to be sworn of the Privy Council. Mr. Clements R. Markham, C.B., F.R.S., the President of the Royal Geographical Society, is promoted to be K.C.B., and Dr. David Gill, F.R.S., Astronomer Royal at the Cape, is made a C.B. Dr. J. G. Fitch, who until lately was Chief Inspector in the Education Department, and Mr. Le Page Renouf, the Egyptologist, have been knighted.

THE Chemical Society's Lothar Meyer Memorial Lecture will be delivered by Prof. P. P. Bedson, at an extra meeting of the Society on Thursday, May 28.

THE Cracow Academy of Sciences has appointed Prof. L. Natanson as its representative at the forthcoming Kelvin celebration at Glasgow.

THE Council of the Sanitary Institute have accepted an invitation from the city and county of Newcastle-upon-Tyne to hold a Sanitary Congress and Health Exhibition in that city in the autumn of this year.

PROF. ANGELO HEILPRIN has been appointed to represent the Academy of Natural Sciences of Philadelphia at the Mining and Geologica Millennial Congress, to be held at Budapest, September 25 and 26, in connection with the celebration of the founding of the kingdom of Hungary. Messrs. Persifor Frazer, Angelo Heilprin, Benjamin Smith Lyman, and Theodore D. Rand have been appointed by the Academy as the Committee on the Hayden Memorial Geological Award for 1896.

ON the occasion of the Hungarian Millennium, the Emperor Francis Joseph has authorised the Budapest University to confer the following honorary degrees:—On Prof. Henry Sidgwick, of Cambridge, the honorary degree of Doctor of Political Economy; on Prof. J. S. Billings, of Philadelphia, and on Sir Joseph Lister the honorary degree of Doctor of Medicine; on Mr. Bryce, M.P., Mr. Herbert Spencer, Lord Kelvin, and Prof. Max Müller, the honorary degree of Doctor of Philosophy.

THE conversazione of the Society of Arts will be held at the South Kensington Museum on Wednesday, June 17.

PROF. E. SUESS, the well-known geologist, and Liberal politician, has just retired from his party in the Austrian Parliament.

THE death is announced of Prof. Germain Sée, the distinguished French pathologist, and member of the Paris Academy of Medicine.

A CONVERSAZIONE of the Society for the Protection of Birds will be held at the Royal Institute of Painters in Water Colours, Piccadilly, to-morrow evening.

WE learn, from the *Journal de Botanique*, that M. L. Diguet has been commissioned by the Minister of Public Instruction for France, and by the Museum of Natural History, with a botanical mission to Lower California, where he will probably make a prolonged stay.

MR. MARK JUDGE, Honorary Secretary to the Sunday Society, sends us the following statement of attendances on Sunday last at the great national museums in London:—South Kensington Museum, 2659; Bethnal Green Museum, 799; Geological Museum, 212; British Museum, 1790; Natural History Museum, 2398; National Gallery, 2106. The total is 9864, which number of visitors may be taken to justify the continuance of the Sunday opening of the museums.

THE Croonian Lectures of the Royal College of Physicians will be delivered on June 2, 4, 9 and 11, by Dr. George Oliver, who will take for his subject "The Study of the Blood and the Circulation."

ON Tuesday next, May 26, Prof. T. G. Bonney, F.R.S., will begin a course of two lectures, at the Royal Institution, on the "Building and Sculpture of Western Europe" (the Tyndall Lectures). On Thursday (May 28) Dr. Robert Munro will deliver the first of two lectures on "Lake Dwellings," and on Saturday (May 30) Dr. E. A. Wallis Budge, Keeper of the Egyptian and Assyrian Antiquities, British Museum, will begin a course of two lectures on the "Moral and Religious Literature of Ancient Egypt." The Friday evening discourse on June 5 will be on "Electrical and Magnetic Research at Low Temperatures," the lecturer being Prof. J. A. Fleming, F.R.S.

A severe storm is reported by Reuter to have swept over Sherman, Texas, on Friday afternoon, completely destroying the western portion of the town. It is estimated that 120 persons, a large proportion of whom were negroes, were killed, and that 100 were injured. The storm, which travelled in a northerly direction over a path of 400 yards wide, swept everything before it. A waterspout burst at the same time over Howe, Texas, where eight persons were killed and many injured.

The Swedish Tourists' Club has organised an expedition to the Great Lake Falls next August. The object of the expedition is to give those who join it an opportunity of seeing the total eclipse of the sun on August 9, of becoming acquainted with Lapland, and at the same time to see two of the finest waterfalls in Europe—the Great Lake Falls (Stora Sjöfallet) and Harsprånget. The party will start from Gellivare on August 3. Further information with reference to the journey can be obtained at the Tourists' Club, No. 28 Fredsgaten, Stockholm.

Prof. S. P. Langley, who has for some time devoted attention to the problem of artificial flight, appears to have attained a remarkable degree of success. The New York correspondent of the *Daily Chronicle* reports that trials made with Prof. Langley's "aërodrome" have clearly demonstrated the efficiency and practicability of the invention. It is stated that "two upward ascents of about half a mile were made at a speed of twenty miles an hour. The machine in motion suggests a huge bird, soaring in large curves. When the steam gave out, the aërodrome sank gracefully and was picked up undamaged. No passengers were carried in the trial trips."

With reference to the reported dispatch of an American Antarctic Expedition under Dr. Cook, which was referred to in Nature last week, we observe in the new number of the quarterly *Bulletin* of the American Geographical Society, New York, that the report is entirely incorrect, and that there does not appear to be "any immediate prospect of the launching of such an enterprise." The Belgian expedition, on the other hand, seems to be in course of rapid organisation; but it does not appear that the necessary funds have yet been completely subscribed. It will be under the command of Lieut. de Gerlache, of the Belgian Navy, and M. Arctowski will have charge of the oceanographical work to be carried out on board.

The second annual meeting of the Botanical Society of America will be held in Buffalo, N.Y., on Friday and Saturday, August 21 and 22, 1896. Dr. William Trelease, Director of the Missouri Botanical Garden, will retire from the presidency, and will be succeeded by the President-elect, Dr. Charles E. Bessey, Professor of Botany in the University of Nebraska. At the evening session on Friday, August 21, the retiring President will deliver a public address on "Botanical Opportunity." The Botanical Society of America is affiliated with the American Association for the Advancement of Science, the sessions of which this year begin on Monday, August 24, in Buffalo.

The Batavian Society of Experimental Philosophy at Rotterdam has offered prizes for the following botanical subjects:—The anatomical and chemical composition and vital functions of one or more at present undescribed species of plant natives of Holland or of the Dutch colonies; description of the vital conditions and properties of a mould-fungus, ferment, or bacterium of technical importance; new investigations on the action of flowers of sulphur or of copper salts on a pathogenous parasite; investigations on the presence, formation, and properties of the latex in the leaves of the caoutchouc-plant. For each subject a medal worth thirty duc. is offered; the work must be hitherto unpublished, and may be written in Dutch, German, French, or English. The essays must be sent, before February 1, 1897, with a motto, and the name in an enclosed envelope, to Dr. G. J. W. Bremer, Secretary to the Society, Rotterdam.

The Ottawa correspondent of the *Times*, writing under date May 19, says: "The Royal Society of Canada, representing all the scientific and learned societies in the Dominion, met to-day. The business transacted included the adoption of a memorial to the Governor-General on the subject of the sixth resolution of the Prime Meridian International Conference of 1884, praying his Excellency's intervention with the home authorities with respect to the unification of nautical, civil, and astronomical time. Evidence was submitted establishing the fact that ship masters, both British and foreign, are almost unanimously in favour of the proposal, and that Canada, not only as a maritime portion of the Empire, but in other respects also, is peculiarly interested in the matter. It is strongly urged that the reform should be adopted so as to come into effect on the first day of the new century, and that, as nautical almanacs are prepared some years in advance, no time should be lost in adapting them to the change."

The Paris correspondent of the *Chemist and Druggist* remarks that there are several pictures of interest to men of science at the Salon of the Champs Elysées this year. The most attractive of these is a decorative panel by Fournier, ordered by the State for the purpose of being placed in Pasteur's old laboratory at the École Normale Supérieure. The centre figure of the panel is an excellent portrait of Pasteur, who is depicted working by gaslight at a table in his laboratory, and the light is made to illuminate his fine features. Before him is a microscope, and he is shown in a reflective attitude as though about to make an entry in an open book that lies before him. Immediately above him is the figure of a woman personifying Science, receiving another, representing suffering humanity, in her arms. On the left are two young doctors in the act of inoculating a patient. On the right is a group of women, one holding forward her baby. A number of appropriate inscriptions appear on the panel.

The *Weekly Weather Report* of the 16th inst. shows that the rainfall of the British Islands since the beginning of the year is deficient in all districts except the north of Scotland. The greatest deficiency is in the Channel Islands, where it amounts to 6·3 inches; in the south-west of England it amounts to 5·7 inches, and in the south of England to 4·5 inches. The severity of the recent drought may be judged by the following low falls in hundredths of an inch between April 17 and May 17, inclusive, in various districts:—Scarborough, 18; Spurn Head, 14; Cambridge, 17; Rothamsted, 8; Loughborough, 7; Oxford 0; London, 4; Dungeness, 10; Holyhead, 15; Prawle Point, 5; Donaghadee, 18; Roches Point, 11; Scilly, 5. The general distribution of barometric pressure over our Islands during the drought has been anticyclonic, with light or moderate north-easterly and easterly winds; while areas of low pressure occasionally passed over the north of Scotland, and occasioned slight falls of rain in the north and west. On the 18th inst., however, a well-marked "V-shaped" depression passed across the northern parts of our Islands, causing rain at many stations, and amounting to half an inch in parts of Scotland.

The rule followed by Irishmen at Donnybrook fair, to hit a head whenever they saw one, seems now to be applied to meteorological instruments. Writing from Edinburgh, Mr. W.

Black says a friend of his recently had his meteorological instruments upset and kicked about by Irish miners working in Lanarkshire. But the exuberance of spirits which led to this destruction is not confined to Irishmen, for Mr. Black says that at Duddingston Loch, some time ago, a number of Bank Holiday savages upset a complete meteorological equipment into the water near which it was installed; while in several northern towns it is necessary to enclose the instruments in iron cages to preserve them from being used as targets by the demon boy. Probably much of the destruction is the result of sheer wantonness, but anthropologists might be able to find evidence that the instruments are considered uncanny, in which case we should have to confess to the survival of the mediæval superstition against meteorology.

MOST workers with Röntgen rays have observed that a photographic plate becomes more or less fluorescent when the rays fall upon it. Mr. W. J. D. Walker informs us that a Paget x x x x x plate used by him fluorised so decidedly, that it made a very fair fluorescent screen, capable of showing coins in a purse, the bones of the fingers, screws and nails in a wooden block, and similar objects.

A NUMBER of excellent Röntgen photographs received from Mr. H. S. Pyne, of King William's College, Isle of Man, show that the Wimshurst machine is capable of producing effects comparable with those given by means of a good induction coil. The machine employed had plates fifteen inches in diameter, and the best results were obtained when the discharge was made intermittent. By this means the tube is rested, and, even with a quarter of an hour's continuous work, the phosphorescent area does not become appreciably warm. A Newton's "focus" tube was used, and the definition of the pictures produced by its radiations is exceedingly good and sharp. All the plates used were "Ilford rapid," with the exception of one, being a "Cadett" lightning. The latter plates Mr. Pyne has found to require the least exposure.

THE peculiar glow exhibited by a "focus" tube working well furnishes a good criterion of efficiency as regards Röntgen rays. A more definite means of comparing the actinic power of the radiation has been produced by Messrs. Reynolds and Branson, Leeds. A small quadrant of aluminium is constructed in concentric terraces, ranging from one millimetre to ten millimetres in thickness. By holding this quadrant between an excited Crookes' tube and a phosphorescent screen, the thickness of aluminium which the rays are capable of traversing can be seen upon the screen; or, by substituting a sensitive plate for the screen, the effect may be photographed. The "X-ray meter," as the quadrant is called, thus furnishes an easy means of comparing the intensity of Röntgen rays emitted by different tubes and by the same tubes at different times.

FROM Prof. A. Battelli and Dr. A. Garbasso, of Pisa, we have received several interesting papers describing their experiments on Röntgen rays. Referring to the discovery that the time of exposure required for taking photographs with these rays can be greatly shortened by placing certain fluorescent substances behind the photographic plate, the authors point out that they described a method of doing this in the January number of *Il Nuovo Cimento*. In some cases Prof. Battelli and Dr. Garbasso obtained good photographs with an exposure of only two seconds. In their paper, experiments were also described proving that Röntgen rays can be reflected (or at any rate scattered) from surfaces, but indicating an absence of refraction. Since the appearance of the above paper, Prof. Battelli has communicated two further papers to the same journal. In the first, the author arrives at the conclusion that Röntgen rays behave as if they emanate from the base of the vacuum tube rather than from the anode or kathode, also that they are emitted even after the discharge in the tube has ceased (as proved by the discharge of an electrified disc in the neighbourhood of the tube). In the second paper, Prof. Battelli deduces that the rays which emanat from the kathode in a vacuum tube possess photographic properties; that their action increases as the rarefaction increases (at least up to $\frac{1}{200}$ mm. of pressure); and that some of the ray are deflected by a magnet, while others are not. It is hence quite permissible to maintain that Röntgen rays exist in the interior of the tube. This view does not contradict the result that the rays *appear* to have their origin at the point where kathodic rays meet with an obstacle. It is easily seen that such an obstacle would act on the rays either as a filter or by scattering them in all directions.

THE various manurial trials conducted on behalf of the County Councils of Cumberland, Durham, and Northumberland in 1895, form the subject of a report by Prof. Somerville, of the Durham College of Science. Results of experiments on turnips, conducted at twelve centres, are considered to give a definite answer to the question as to whether it is the potash, the magnesia, or the salt in kainit that determines its value, its efficacy being attributed to the potash, which is the only substance that has consistently increased the average crop in these trials. No poin has been more clearly demonstrated in the field trials of the last few years than that large dressings of dung or artificial manures d not increase the turnip crop to the extent usually supposed. It argued that they would be more effective if they were applie in small quantities to each crop in the rotation as it came t occupy the land, instead of being, as at present, put into the land, say, every four years, to be exposed to all the wastefu agencies that may operate upon them till the plant food that they contain is exhausted. Manurial reform would seem to be most needed in the case of the artificial manures, since, for the incorporation of dung with the soil, the root-break offers facilities such as are afforded by no other crop in the rotation. The report includes details of experiments with finger-and-toe i turnips, and with *bouillie bordelaise* as a check upon potato disease.

THE report of the field experiments carried out in 1895 by the Agricultural Department of the University College of No: Wales, Bangor, under the auspices of the County Councils of Anglesey, Carnarvon, Denbigh, Flint, and Montgomery, forms a brochure of some fifty pages. The experiments were concerned with the manuring of swedes, of pasture land, and of hay fields, the growth of oats from different quantities of seed, and the effects of various manures on the growth of vegetables. The work was conducted at more than thirty distinct centres, scattered over the five counties, and the question arises as to whether this is not too diffuse an application of energy to afford the best results. It is stated that within the last eleven years the trials "have gone on increasing until the number of centres has almost reached forty." Some of these places are nearly 150 miles apart, and many are far removed from railways. It is, however, correctly understood that these field trials are really intended to serve the purpose of object-lessons, "in which conclusions arrived at elsewhere may be made use of for the benefit of particular districts." There is considerable variation in the results obtained from the use of the same manures when applied to hay and pasture lands in different parts of North Wales. Phosphatic manures have proved the most satisfactory, and of these the most economical manure in the majority of cases was basic slag. The experiments, which must have involved a large amount of work, were conducted by Messrs. T. Winter, Bryner Jones, R. H. Evans, and F. V. Dutton. Every care should be taken to secure exactitude in such reports as this, intended for circulation amongst farmers

We notice that no denomination is given to the weights of seeds in the table on p. 47, though pounds, of course, are intended.

Messrs. Macmillan and Co. have made arrangements for the issue in New York and London of a "Dictionary of Philosophy and Psychology," under the editorial supervision of Professor Baldwin of Princeton University. All the matter in the Dictionary will be original and signed, and the several departments will be entrusted to men most competent to deal with them.

Writing with reference to the diagram published in Nature of February 27 (vol. liii. p. 404), to illustrate the movements of the terrestrial pole determined by Prof. Albrech, Mr. T. W. Kingsmill points out that the irregular variations in the curve are apparently coincident with remarkable seismic disturbances. He therefore suggests that there is a connection between movements of the earth's axis and unusual seismic activity.

We have received two more of the valuable publications of the Geological Survey of Canada, forming Parts B and M of Annual Report, vol. vii. The first of these is a Report on the Kamloops map-sheet of British Columbia, by Dr. G. M. Dawson. It is accompanied by two maps of the area, one strictly geological, the other glacial and economic, and the Report itself contains a number of reproductions of photographs of the district. The rocks of the area range from Cambrian to Tertiary and later, and are described at length; while topographical, meteorological, and mineralogical observations are also recorded. The whole volume consists of over 400 pages. The second is a Report by Mr. R. Chalmers on the surface geology of parts of New Brunswick, Nova Scotia, and Prince Edward Island. Besides minor matters of local interest, it includes discussions on the origin of the Bay of Fundy depression, the glacial striæ of the district, and the destruction of the forests. Several maps accompany the Report, and a photograph of the famous tidal bore in the Petitcodiac River, Bay of Fundy, deserves special mention.

True it is that at the Royal Victoria Hall, in Waterloo Bridge Road, music and mummery occupy a larger share of attention than lectures on scientific subjects. South London audiences have but a mere *penchant* for the generous new wine of science; they reserve their capacities for the variety entertainments. But though the audiences on Tuesday evenings, when scientific discourses are delivered, are very much smaller than on the evenings when a lighter vein predominates, they listen in a way which shows that they appreciate the fare provided for them. And it is satisfactory to know that most of the lecturers are in the front rank of scientific investigators, for this fact may be taken as a guarantee that sound information is imparted. The list of lecturers and subjects given in the report on the work of the Hall during 1895 is most creditable to the energy of Miss Cons, the Secretary, and to the generous spirit of the men of science who gave their services.

Following up the work which resulted in the preparation of the phosphoryl chlorobromides, M. Besson (*Comptes rendus*, May 11), by a similar method, has succeeded in preparing the corresponding thiophosphoryl derivatives. A mixture of hydrobromic acid and thiophosphoryl chloride passed over pumice at 400°–500° C. yields a liquid from which it is possible, by fractional distillation under reduced pressure (60 mm.), to separate both the intermediate chlorobromides. These substances resemble in their general behaviour the corresponding phosphoryl compounds. They undergo partial decomposition when distilled under ordinary atmospheric pressure, and are slowly acted upon by water. The chloromonobromide, ($PSCl_2Br$), has been previously obtained by Michaelis by the action of bromine upon $PSCl_2(OC_2H_5)$, but his product seems to have been impure.

The additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*, ♀) from India, presented by Mr. F. Greswolde-Williams; a Red-fronted Lemur (*Lemur rufifrons*, ♂) from Madagascar, presented by Mr. E. A. Pardoe; a Grison (*Galictis vittata*), a Black Tortoise (*Testudo carbonaria*), a Brazilian Tortoise (*Testudo tabulata*), a Rough Terrapin (*Clemmys punctularia*), two Scorpion Mud Terrapins (*Cinosternon scorpioides*) from South America, presented by Mr. J. J. Quelch; a Lesser Kestrel (*Tinnunculus cenchris*), captured off the coast of Sicily, presented by Mr. J. L. Spaull; a Natal Python (*Python sebæ*, var. *natalensis*), a Ring-hals Snake (*Sepedon hæmachetes*) from South Africa, presented by Mr. W. Champion; a Common Viper (*Vipera berus*), British, presented by Mr. H. L. C. Barret; eight Esquimaux Dogs (*Canis familiaris*), Arctic Regions, deposited; a Pied Crow Shrike (*Strepera graculina*) from Australia, two Whooper Swans (*Cygnus musicus*), European, purchased; two Barbary Wild Sheep (*Ovis tragelaphus*), born in the Gardens.

Erratum.—In the letter entitled "Simple Huyghens' Apparatus for the Optical Lantern," in the issue of Nature for April 9, instead of "a thickness of 1½ inches or more," read "of ½ inch or more."

OUR ASTRONOMICAL COLUMN.

The System of Castor.—A very interesting discovery with regard to this well-known binary star has been made by Dr. Belopolsky (*Bull. Acad. Imp. Sci. St. Petersbourg*, vol. iv. No. 3). In addition to the two luminous bodies, which perform their revolution in a period of about 1000 years, Dr. Belopolsky's observations indicate that the brighter star, α_1 Geminorum, has a dark companion very similar to that of Algol, except that it never produces eclipses. The existence of this dark body was suspected in 1894, and it was fully confirmed by photographs of the spectrum taken at Pulkowa early in the present year, showing periodic changes in the velocity of the star along the line of sight. Thirteen photographs were obtained, and from these the velocities of α_1 Geminorum towards or away from the sun were deduced. Although the available data are insufficient for a complete determination of the orbit, it may be taken to be circular as a first approximation, and a period of revolution of 2·98 days sufficiently accords with the spectroscopic measurements. The proper motion of the system of α_1 is 1·0 geographical mile (=4·6 English miles) per second away from the sun, while the relative orbital velocity is 4·5 geographical miles (20·7 English miles) per second.

Dr. Belopolsky also tabulates the wave-lengths of some of the principal lines in the spectrum of α_1 Geminorum, which somewhat resembles that of Sirius in having broad lines of hydrogen, and many finer lines which are chiefly due to iron. α_2 Geminorum gives a spectrum with less numerous lines.

Efficiency of Photographic Telescopes.—Dr. Isaac Roberts has recently conducted an important series of experiments with the view of ascertaining the relative efficiency of a reflector and of portrait lenses for the delineation of celestial objects (*Monthly Notices*, vol. lvi. p. 372). It has often been asserted that portrait lenses have, by reason of their short focal lengths in relation to their apertures, greater photographic power than instruments of other forms; but this does not accord with Dr. Roberts's experience. A portrait lens of Dallmeyer's latest pattern, 3½ inches aperture and 9½ inches focus, and a 5-inch Cooke patent triplet lens of 19·2 inches focus, were attached with their cameras to the 20-inch reflector, and photographs of the same regions were taken simultaneously with the three instruments. The 5-inch lens was stopped down to a ratio of 1 to 4·8, while the ratio of aperture to focus in the case of the reflector was 1 to 4·9. In three exposures on the region of M. 33 Trianguli, the stars were 3½ times more numerous on the reflector photograph than on the photograph taken with the 5-inch lens in an equal angular area, and 7·8 times more numerous than in the case of the 3½-inch lens. At the same time the reflector photograph showed the nebula more extensively, more clearly depicted, at least two stellar magnitudes denser, and with far more structural details than can be seen on the other photographs.

Similar results were obtained with exposures on other regions, and in all cases the nebulosity shown on the plates taken with the reflector was denser than that registered by the portrait lenses in the approximate ratio of the relative numbers of faint stars shown on plates exposed simultaneously. Figures are also given which demonstrate the superiority of the reflector over the Willard lens, with which Prof. Barnard has obtained such striking photographs.

The experiments seem to point to a practical limit of about 1 to 5 for the ratio of aperture to focus in the construction of instruments for celestial photography. Dr. Roberts further concludes that it is not possible, as is often stated, that a photographic instrument of the portrait lens form can imprint images of nebulæ that are fainter than the faintest star-images imprinted at the same time and under exactly similar conditions.

Solar Photography at Meudon.—In his recent presidential address to the Astronomical Society of France, Dr. Janssen gave a few particulars as to the progress of solar photography at Meudon. The well-known photographs taken some years ago revealed much that was new in regard to the granulation of the photosphere, and as the work has been continued, it has been found that the faculæ, and even the striæ in the penumbra of a sun-spot, have a granular structure like the rest of the solar surface. One can look upon the granule, or small photospheric cloud, as an element of the photosphere just as the cell is that of organic tissues. These granular elements are very small, sometimes being only one or two-tenths of a second in diameter; and exceptionally favourable atmospheric conditions appear to be necessary for their proper investigation.

University Observatories in America.—We learn from *Science* that at the last session of the Illinois Legislature an appropriation was made for the erection and equipment of an observatory for the State University at Champaign. The designs for the building were made, under direction of Prof. Ira O. Baker, by the Architectural Department of the University. The instrumental equipment, consisting of a 12-inch equatorial, a 3-inch combined transit and zenith telescope and a chronograph, will be made by Warner and Swasey, the optical parts being made by Brashear. This makes four universities which have established observatories within the past year, all of which have ordered telescopes from Warner and Swasey, with optical parts by Brashear. The list is as follows: University of Pennsylvania, Philadelphia (18-inch aperture); University of Ohio, Columbus (12-inch aperture); University of Minnesota, Minneapolis (10½-inch aperture); University of Illinois, Champaign (12-inch aperture).

INTERNATIONAL CATALOGUE OF SCIENCE.

We have been requested to print the following circular, which the Royal Society has recently issued to the foreign and other delegates of various nations, now numbering about thirty, whose appointment has been already notified:—

"In anticipation of the forthcoming International Conference to consider the preparation of a catalogue of scientific literature by international co-operation, we are directed to address to you the following:—

"It is proposed that the Conference shall be held at the rooms of the Royal Society, Burlington House, London, *beginning on Tuesday, July* 14, 1896, at 11 a.m.

"One of the earliest acts of this first meeting will be to appoint an organising committee to determine the mode of procedure (including the language or languages to be used at the Conference), the course of business, and the way in which votes shall be recorded on occasions when it will be necessary to have recourse to formal voting.

"The Committee of the Royal Society hopes to be in a position to bring definite proposals before the Conference with regard to its main work. Meanwhile, we are directed to submit to your consideration the following provisional suggestions, and to invite remarks from you upon them:—

"I. That the proposed International Authors and Subject Catalogue of Scientific Literature shall be restricted, in the first instance, to branches of pure science, such as mathematics, astronomy, physics, chemistry, geology, zoology, botany, physiology, and anthropology, to the exclusion of applied sciences, such as engineering, medicine, and the like: the determination of the distinction between pure and applied science being left to the Conference.

"II. That in such an International Catalogue of Science all definite contributions to pure science shall be thoroughly indexed, whether occurring in books, memoirs, &c., treating of pure science, or in those devoted to applied or practical science—in other words, that the catalogue shall not be confined to papers published in certain periodicals, or to books of a certain category.

"III. That with regard to the form of the said Catalogue:—

"(*a*) There shall be a first issue of authors' titles, subject-matter, &c., in the form of *slips* or *cards*, which shall be distributed as speedily and as frequently as possible to subscribers generally.

"(*b*) That a further issue in book form, in a state for use as a permanent work of reference, shall take place at such intervals as may be determined on, parts corresponding to the several sciences being, if found desirable, published separately.

"IV. That, in order to secure the preparation and publication of such an International Catalogue, a Central Bureau shall be established under the control of an International Council.

"V. That the whole of the Catalogue shall be prepared and issued subject to the authority of the International Council, and that any particular undertakings which may be allotted to particular countries, institutions, or persons, shall be subsidiary to the work of the Central Bureau and subject to its control.

"VI. That the cost of preparing and publishing the said Slip- and Book-Catalogues at the Central Bureau during the years 1900–1904, in so far as these are not met by sales, shall be provided for by means of a guarantee fund, and that application be made to governments, learned societies, institutions, and individuals throughout the world, to assist in establishing such a fund.

"The Conference will also have to take into consideration the following matters, among others:—

"(*a*) Supposing that the plan of a Central Bureau is adopted, where shall the Bureau be placed?

"(*b*) The mode of appointment and organisation of the International Council in charge of the Bureau.

"(*c*) The language or languages to be adopted for the Catalogue.

"(*d*) The system of classification to be adopted in the subject index. It is suggested that the decimal system of Dewey may be so amended as to be worthy of adoption.

"There is necessarily the greatest difficulty in estimating the cost of the work in advance, or in forming an opinion as to the extent to which such an enterprise will be self-supporting. It will probably, therefore, be best to raise a guarantee fund covering a period of not less than five years, within which period it will undoubtedly be possible to determine the cost of the enterprise. The annual sum to be thus secured may be approximately estimated at ten thousand pounds.

"We are, your obedient servants,

"M. Foster, Secretary, R.S.
"Rayleigh, Secretary, R.S.
"E. Frankland, Foreign Secretary, R.S."

THE FRENCH UNIVERSITIES.[1]

On March 5 the Chamber of Deputies voted unanimously for a reconstitution of the French universities. In order to understand the object of this important law, it is necessary to recall the circumstances and the legislative proceedings which brought about its adoption.

Until 1875 the faculties of literature, science, law, and medicine existed separately in France, without being united by a single tie, even when four of them (a university, in the acknowledged sense of the word) existed in the same town. In 1875 the National Assembly announced the liberty of higher instruction, permitted the installation of free faculties, and accorded to the group of three faculties (refused to similar groups of the faculties of the State) the title of University. This vote increased at once, by reaction, the force of the movement, which, since the fall of the Empire, claimed unsuccessfully, by means of such men as Guizot, Cousin, Duruy, and Renan, the constitution of State universities. In 1877 a first scheme of law was handed over to M. Waddington, then Minister of Public Instruction, by a Committee of eminent men

1 Condensed from an article in the *Revue de l'Université de Bruxelles*, February 1896.

and jurists, amongst whom were Renan, Taine, Berthelot, and others.

This led to the creation of seven complete universities, to which the nearest separate faculties attached themselves. M. Waddington, after having looked over the scheme, did not ask for a discussion. He thought that universities could not be established before university life had been founded, before the material, scientific, and moral situation of the faculties had been ameliorated. It is in this direction that the reforms were directed.

In 1885, the localities of the faculties having been changed, their scientific instruments being complete, their courses extended, at the cost of great pecuniary sacrifices, the question of universities was again renewed. The Minister of Public Instruction, at this time M. R. Goblet, signed two important resolutions. For each group of faculties there was instituted a general Council composed of two delegates of each faculty, with extended functions for academic, scientific, administrative, financial and disciplinary matters. The Rector of the Academy received the presidency. The ordinary life of the faculties of the same town was thus created. Each one of the faculties received, besides, confirmation of the right that they possessed since their creation, but which was repealed in deed to receive endowments, legacies and relief.

The faculties became therefore civil persons, but their grouping remained extra-legal, and had no judicial unity. It is in a scheme of law presented to the Senate in 1890 by M. Bourgeois, then Minister of Public Instruction, that the proposition is first made to confer the civil personality and the name of University on the groups, comprising at least the four faculties of law, literature, science and medicine, and to give to the universities the autonomy of their budget, by abandoning to them all the receipts which they effected (right of inscription, of study, revenues) for covering their expenses, with the help of a State subsidy. This project, rather badly received by the Senate, was sent back to a Commission, which very soon gave up its examination. It met with the strong opposition of the senators who represented the towns of the little groups of two or three faculties, which could not, by the terms of the project, pretend to the rank of University.

In spite of this repulse, the Minister of Public Instruction, and especially M. Liard, the eminent Director of Higher Instruction, were not discouraged. They succeeded in having inserted in the Finance Law of April 28, 1893, an article (No. 72) which conferred civil personality on the faculties in the same academic resort. The Senate, averse to the project of 1890, accepted the provision of 1893 by 212 votes against 56. Thus new progress was made.

Nevertheless, as it became more evident that the Senate would never consent to sacrifice the little groups of faculties, the partisans of the universities had to content themselves, in order to obtain anything, with demanding less.

In 1895, M. R. Poincaré presented the proposition which has just been voted for by the Chamber, and which he defended as Reporter, at the side of his successor in Public Instruction, M. Combes.

Briefly, in the terms of the project, the bodies of faculties, instituted in 1893, take the name of University; the general councils of the faculties, created in 1885, become councils of the university. In 1898 each faculty will have a budget of its own.

This arrangement has its importance, for it confers on certain groups of the university considerable receipts—646,000 francs at Paris, 105,000 at Bordeaux, 128,000 at Lyons, 83,000 at Lille.

By the vote of the Chamber, and that of the Senate, the universities, suppressed by the Revolution, will be reconstituted in France and endowed with civil personification. The new law is, on the other hand, but the result of the long evolution commenced twenty years ago. It perpetuates results already attained, and so little contested, that in 1889 M. Gréard, in his inaugural discourse at the Sorbonne, talked of the University of Paris, and the new buildings of the Faculties of Lille bear the inscription "University of Lille."

It is certainly to be regretted that the proposal of 1890 was not adoped. Real universities must include four faculties. And, as the Rector of the Catholic Institute of Paris, M. d'Hulst, has said at the Chamber, it is a delusion to call the union of only two or three faculties a university. It may be presumed that the incomplete groups, in order to maintain their new name and the concurrence of the complete groups, will try to give themselves the faculties which are wanting. If they do not succeed, they will remain, of necessity, in the shade; and it is better, in short, to see the faculties of Paris become a university, even if those of Clermont-Fenaud receive the same title, than to see the ambiguous situation, created in 1885, continued.

There are fifteen groups of faculties in France; there would, therefore, be fifteen universities, of which seven are complete: Paris, Lyons, Bordeaux, Toulouse, Montpellier, Lille, and Nancy. It is to be remarked that the southern half of the country will possess four of the seven universities. The incomplete universities are Aix-Marseilles, Rennes, Caen, Poitiers, Grenoble, Dijon (law, science, and literature), Clermont, and Besançon (science and literature).

The above-mentioned towns, Clermont and Besançon excepted, contain a preparatory school of medicine. Many of these schools will probably be turned into faculties.

NATIONAL ACADEMY OF SCIENCES.—WASHINGTON MEETING.

THE recent annual meeting of the National Academy of Sciences in Washington brought together an unusual number of members; and the papers read during the first three days of the meeting included several of special interest and value.

Naturally the Röntgen rays have been the prominent topic, and it is fortunate that most of the successful investigators have attended and read papers, or participated in the discussions. Some errors which have gained credence and wide publication have been corrected, and perhaps the most satisfactory feature of the discussion has been the elimination of these errors, and the correction of too hasty generalisation from experiments conducted without sufficient care.

What the rays are Prof. Rowland frankly admits we do not know, nor are we perceptibly nearer a solution of the problem than when Röntgen first launched his epoch-making essay.

Prof. Rowland presented to the Academy some notes on the rays, in which he said in part that investigators of the source of these rays generally overlook the fact that electrical currents are almost invariably accompanied by oscillations, so that each pole is alternately anode and kathode, thus vitiating any generalisations as to the anode or the kathode being the source of the rays. He mentioned that the rays are developed to the greatest extent when the kathode rays fall on the anode, and hence a kathode ground to a reflecting surface focused on the anode gives the best results. This fact is utilised in the construction of the "focus-tubes" now largly used in Röntgen photography.

Prof. Rowland has obtained good results by using perfect vacuum tubes in which the electrodes are brought within one millimetre of each other. The source of rays here is less than 1/1000 of an inch in diameter. This throws a shadow with remarkably sharp outline, being less than 1/1000 inch. The width of the image gives the limit of wave-length—if it is indeed an undulation, and not the projection of material particles—not greater than 1/8 the length of waves of yellow light.

A paper on the source of the Röntgen rays was read by Prof. A. A. Michelson and S. W. Stratton. Prof. Michelson maintains that these rays are not essentially different from those of Lenard. The latter produce their effect mostly within the tube, the former without; but Lenard also found an actinic effect outside the tube. He also brought forward evidence to show that Röntgen rays radiate in all directions from the surface first encountered by the kathode rays, and do not start from the anode.

Prof. A. M. Mayer read several papers. He showed that investigations of polarisation of these rays must be made with some very thin substance of low density, herapathite being the best; but this substance, which is an iodo-sulphate of quinine, is difficult to obtain. He described the process, already communicated by him to NATURE (April 2). On using plates of herapathite with three different exposures of half-hour, one hour, and three and a half hours, no polarising effect was produced. He remarked that calc-spar was utterly unavailable as a test of polarisation of these rays, because it could not be procured of sufficient thinness for the rays to penetrate, Hence the researches of some experimenters, though widely published, were of no value whatever. He has determined the density of herapathite with great accuracy and by repeated

experiments, and finds it much smaller than Herapath did, namely, 1·557.

Prof. Mayer also gave formulæ of transmission of Röntgen rays through glass, tourmaline and herapathite. To determine whether rays just go through or nearly go through, he uses a wire grating which will appear in the picture if rays go through. Transmission depends on the thickness of the glass plus the time of exposure. Glass of various thickness is used, one plate being superposed upon another in successive gradations. The eye cannot distinguish a difference less than about 1/100, and this is what passes through glass of five millimetres thickness. If we begin with glass 1/10 millimetre thick, it absorbs 1/10 of the rays, and each superposed 1/10 millimetre absorbs 1/10 of the residue, so that the formula in general is $I' = Ia^t$. It is evident, therefore, that there is no constant ratio of comparison of absorption by different materials, because the successive powers of "a" have not the same ratio to each other that the first powers have. In the case of herapathite the absorption (a) is found to be ·9382, so the formula becomes $I' = I \cdot 9382^t$. The formula for tourmaline is the same as for glass, so tourmaline is a very imperfect substance to use.

Prof. Ogden N. Rood read a paper detailing his experiments in reflecting the X-rays, which have enabled him to reflect 1/260th part of the rays incident on platinum at an angle of 45° (see NATURE, April 30, p. 614).

Prof. Arthur W. Wright read a paper on the relative permeability of magnesium and aluminium by Röntgen rays. He reported experiments showing that magnesium is much more permeable than aluminium. Magnesium is also more readily wrought than aluminium, thus making it much more desirable to use in the investigation of these rays.

Prof. T. J. J. See, of Chicago University, read a paper on double stars, giving results of three years' observations. He concludes that at the end of 115 years we know accurately only forty; that there is only evidence of disturbing bodies in a few cases, which are indecisive; that great eccentricity of orbit prevails, the average being twelve times as much as that of planetary orbits, and that the law of gravity is rendered probable and may be hereafter confirmed by spectroscopic investigation.

Among other papers read are:—The geological efficacy of alkali carbonate solutions, by E. W. Hilgard, read by G. Brown Goode; on the colour relations of atoms, ions, and molecules, by M. Carey Lea, read by Ira Remsen; on the characters of the Otocœlidæ, by E. D. Cope; on the determination of the coefficient of expansion of Jessop's steel, between the limits of 0° C. and 64° C., by the interferential method, by E. W. Morley and Wm. A. Rogers; on a remarkable new family of deep-sea Cephalopods (*Opistotenthis*), and its bearing on molluscan morphology, and on the question of the molluscan archetype, by A. E. Verrill; on *Pithecanthropus erectus* from the Tertiary of Java, which was discovered by Dubois in 1895, by Prof. Marsh; on the separate measurement, by the interferential method, of the heating effect of pure radiations and of an envelope of heated air, by Wm. A. Rogers; judgment in sensation and perception, by J. W. Powell; exhibition of a linkage whose motion shows the laws of refraction of light, by A. M. Mayer; location in Paris of the dwelling of Malus, in which he made the discovery of the polarisation of light by reflection, by A. M. Mayer. Ira Remsen read a paper on some studies in chemical equilibrium, and several papers were read by title.

The Academy adjourned to meet at New York, November 17, 1896. WM. H. HALE.

THE MANUFACTURE OF ARTIFICIAL SILK.

LANCASHIRE is on the eve of some important expansions of the textile trades, for, from an interesting article in the *Times*, it appears that the manufacture of artificial silk from wood pulp will shortly be added to her industries. At present the wood-silk comes from France, large works having been established at Besançon under patents granted to Count Hilaire de Chardonnet, who discovered the process, and first established in 1893 the fact that it might be made into a commercial success. The demand for the new commodity increased so considerably that the idea of introducing its manufacture into England was mooted, with the result that a number of silk and cotton manufacturers met to discuss the question, and finally sent out to Besançon a deputation, consisting of some of their own number, an engineer, a chemist, and a lawyer, to investigate the subject thoroughly. This was done, and the outlook was found to be so promising that certain concessions have been secured and a company is now in process of formation, and, to begin with, a factory, which will cost £30,000, is to be built near to Manchester for the manufacture of artificial silk yarn from wood pulp, for sale to weavers, who will work it up by means of their existing machinery. The way in which wood pulp can be converted into silk yarn is explained in the *Times*. The pulp, thoroughly cleansed, and looking very much like thick gum, is put in cylinders, from which it is forced by pneumatic pressure into pipes passing into the spinning department. Here the machinery looks like that employed in Lancashire spinning sheds, except that one of the pipes referred to runs along each set of machines. These pipes are supplied with small taps, fixed close together, and each tap has a glass tube, about the size of a gasburner, at the extreme point of which is a minute aperture through which the filaments pass. These glass tubes are known as "glass silkworms," and some 12,000 of them are in use in the factory at Besançon. The effect of the pneumatic pressure in the cylinders referred to above is to force the liquid matter not only along the iron tubes, but also, when the small taps are turned on, through each of the glass silkworms. It appears there is a scarcely perceptible globule. This a girl touches with her thumb, to which it adheres, and she draws out an almost invisible filament, which she passes through the guides and on to the bobbin. Then, one by one, she takes eight, ten, or twelve other such filaments, according to the thickness of the thread to be made, and passes them through the same guides and on to the same bobbin. This done, she presses them together with her thumb and forefinger, at a certain point between the glass silkworms and the guides. Not only do they adhere, but thenceforward the filaments will continue to meet and adhere at that point, however long the machinery may be kept running. In this way the whole frame will soon be set at work, the threads not breaking until the bobbin is full, when they break automatically, while they are all of a uniform thickness. The new product is said to take dye much more readily than the natural silk. The chief difference in appearance between the natural and the artificial silk is in the greater lustre of the latter. The success already secured by the new process in France is such that the introduction of the industry into Lancashire is expected to produce something like revolution in the conditions of trade there, not only by bringing into existence a new occupation, but also by finding more work for a good deal of the weaving machinery that is now only partially employed.

A THEORY OF THE X-RAYS.[1]

THE principal facts, which any satisfactory theory of the X-rays is called upon to explain, may be summarised as follows:

(1) The production of the rays by electric impulse, at the kathode,[2] in a highly exhausted enclosure.

(2) Propagation in straight lines and absence of interference, reflection, refraction and polarisation.

(3) The importance of density of the medium as the determining factor in the transmission of the rays.

(4) The production of fluorescence and actinic effects, and the action on electrified conductors.

Two theories have been proposed to account for these remarkable phenomena: (1) the theory of longitudinal waves; (2) the theory of projected particles.

In reference to the first theory it may be said that unless it is proved that an oscillatory discharge is essential to the production of the X-rays, there can be no reason for supposing that these rays are of a periodic nature—that they are wave-motion as commonly understood. The absence of interference, reflection and refraction is also a very formidable difficulty. Attempts have been made to account for the absence of these invariable accompaniments of every known form of wave-motion, but, as I think, with very indifferent success.

The most serious difficulty in the second theory is the attempt to explain the passage of the electrified particles of the residual gas (or of the electrode) through the walls of the

[1] From the *American Journal of Science*, April.

[2] Even should further experiment prove that the X-rays proper originat at the first obstruction encountered by the discharge, the fact remains tha this discharge originates at the kathode.

vacuum tube. The query at once arises, if glass is permeable to these particles in virtue of their relatively great velocity, why is it not permeable (in lesser degree) to the same particles moving with smaller velocities? That it is not, is evident from the fact that vacuum tubes retain their high degree of exhaustion unimpaired for years.

In view of these difficulties, I would propose a third theory, which may be called the "ether-vortex" theory.

Let it be supposed that the X-rays are vortices of an intermolecular medium (provisionally, the ether[1]). These vortices are produced at the surface of the kathode, by the negative charge, which forces them out from among the molecules of the kathode.

Let us now apply the tests above mentioned.

According to this theory, an oscillatory discharge, while it may be just as effective as a series of separate impulses, is not essential to the formation of the vortices. The vortices being forced outwards from the surface of the kathode by the negative charge, the effect of the positive charge at the anode would be to drive them in. Hence their appearance at the kathode alone.

One of the greatest puzzles connected with the behaviour of the X-rays is the fact that while they can pass almost unimpeded through air at atmospheric pressure (let alone water, glass, wood, flesh, bone, and metals) *when once outside the enclosure in which they are produced*, they cannot even reach the walls of the enclosure, except there be a very high vacuum within. This problem receives a very natural solution if it be considered that, in order that ether-vortices may result from the electrical impulse, this impulse must be communicated to them; and must not be dissipated in the interchange of molecular charges which accompanies, or rather produces, the discharge at moderate or high pressures.

As exhaustion proceeds there are fewer molecules present to effect this discharge with sufficient rapidity, and as this limit is approached there will be a division of the energy of the electric impulse between the electrified molecules and the ether-vortices, and in the end all the energy of the discharge will be confined to the latter.

The reason for the non-appearance of the rays under ordinary conditions is not that the rays cannot reach the walls of the enclosure or pass through them, but that they cannot form at all. The propagation of vortices in straight lines, the absence of interference phenomena, of reflection, refraction and polarisation, follow from the properties of vortices, and from the absence of anything corresponding to a wave-front. The passage of an ether-vortex through a mass of matter may be compared with a passage of a smoke-ring through a wire gauze screen or a series of such; and as the motion of the rings is more impeded the greater the diameter and the number of wires per unit volume, so, the greater the number and the size of the molecules—that is, the greater the density—the more effective will the medium be in dissipating the energy of the ether-vortices.

The production of fluorescence, actinic effects, and the dissipation of electric charges by light (which is an ether motion) would make it at least probable that similar (though perhaps not identical) effects would be produced by the motions of ether vortices.

Prof. J. J. Thomson has measured the velocity of kathode rays and obtained a result so very far less than the velocity of light as to preclude entirely the idea of there being any connection between the two. If these results can be made to apply to the X-rays, the analogy with the properties of smoke-rings would lead us to expect such a result. The kathode rays have been shown by Lenard to have a considerable range in their properties, depending on the mode of their origin.[2] It seems likely that their velocities are to a considerable extent dependent on the potential and the suddenness of the electrical impulse; and if this were shown to be true of the X-rays, it would be to that extent a confirmation of the theory.

[1] A possible objection occurs to the formation of ether-vortices in a medium which is usually considered free from viscosity; but the fact that vibrating molecules can and do communicate their motions to the surrounding ether shows that the communication of vortex motion may also be possible.
Though not a necessary part of the theory, it may be considered that the expulsion of the ether-vortices is due to an accumulation of ether in the kathode, and this would lend support to the theory that this accumulation is not merely a result of the negative charge, but that this excess of ether is what constitutes the negative charge.

[2] The distinction between the X-rays and the kathode rays appears to be somewhat artificial, and it seems probable that the X-rays are only kathode rays sifted by the various media they have traversed.

The foregoing evidence may be considered scarcely sufficient to entitle the proposition here advocated to the dignity of a theory, but it may at least merit consideration as a working hypothesis which may serve as a guide in future experiment.

ALBERT A. MICHELSON.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The Oxford University Junior Scientific Club will hold a conversazione on Tuesday evening, May 26. The rooms and laboratories of the University Museum, Oxford, will be thrown open by permission of the delegates and professors, and apparatus and experiments illustrating recent progress in the various branches of natural science will be exhibited. During the evening Prof. Silvanus P. Thomson will give a lecture on "Luminescence," with demonstrations.

On Tuesday, June 2, before the above Club, Prof. W. Ramsay, F.R.S., will deliver the fifth annual Robert Boyle Lecture, on "Argon and Helium, the two recently discovered gases." The "Robert Boyle Lecture" was instituted in 1892, and the lecturers hitherto have been Sir Henry Acland (1892), Lord Kelvin (1893), Prof. A. Macalister (1894), Prof. A. Crum Brown (1895).

The vacancies in the Public Examinerships in the Honour School of Natural Science have been recently filled up as follows:—In Animal Morphology, Prof. E. Ray Lankester and Mr. Adam Sedgwick; in Botany, Prof. D. H. Scott and Mr. R. W. Phillips; in Geology, Prof. A. H. Green and Mr. J. E. Marr; in Physics, Mr. R. E. Baynes; in Chemistry, Prof. W. Ramsay; and in Animal Physiology, Prof. C. S. Sherrington.

The Scholarships and Exhibitions advertised for proficiency in Natural Science are not numerous this year. Merton and New College offer each one, the examination to be held conjointly by the two colleges at the end of June. Magdalen offers one or more Demyships in Natural Science for competition in October, and the Delegacy of Non-Collegiate Students offers a scholarship for Chemistry. There seems to be a tendency at the present time to curtail the number of scholarships in Natural Science.

The Hope Professor of Zoology is giving a course of public lectures at the Museum, on the Hope Collections. The second lecture of the series will be given on Wednesday, May 27, at 2.30 p.m.

Prof. H. A. Miers, F.R.S., Waynflete Professor of Mineralogy, gave his inaugural lecture at the University Museum on Wednesday last.

A Decree will be proposed on the 26th inst. providing for the enlargement and alteration of certain rooms in the University Museum, in order that they may be adapted to the purposes of the Professor of Mineralogy.

Mr. G. F. Scott Elliot gave a lecture to the Ashmolean Society last Monday, on the race elements of South Africa.

CAMBRIDGE.—The dates of the examinations for entrance scholarships and exhibitions in Natural Science at the several colleges during the next academical year, have been announced as follows:—St. John's and Trinity, November 3, 1896; Pembroke, Caius, King's, Jesus, Christ's, and Emmanuel, November 17, 1896; Peterhouse and Sidney, Clare and Trinity Hall, December 8, 1896; Downing, April 20, 1897. The subjects are in General Chemistry, Physics, Zoology, Botany, Geology, and Physiology, two or more sciences being required. Application for particulars should be made to the respective tutors some weeks before the date of the examination. The yearly value of the scholarships varies from £80 to £40.

Vacancies for students of Biology at the University tables in the Zoological Stations of Naples and Plymouth are announced. Applications to occupy these are to be sent to Prof. Newton by May 27.

THE University of Utrecht will celebrate the 260th anniversary of its foundation on June 22 and five following days.

MR. JOHN H. ROCKEFELLER has given to Vassar College (women's) 100,000 dols. for a new building, to be either dormitory or recitation hall.

MR. ANDREW CARNEGIE has given to the city of Duquesne, Iowa, a library, gymnasium, and public bath. The buildings are to cost 150,000 dols.

The following are among recent appointments:—Dr. Otto Fischer to be Extraordinary Professor of Physiological Physics at Leipzig; Dr. Albert P. Brubaker to be Assistant Professor of Hygiene in Jefferson College, Philadelphia; Dr. E. B. Sangree to be Professor of Pathology and Bacteriology in the Vanderbilt University, Nashville, Tenn.

The new buildings at Owen's School for boys, Islington, which were recently opened by the Master of the Brewers' Company, include some new class-rooms for the teaching of practical science. There is a good science lecture-room, as well as physical and chemical laboratories, both well arranged and equipped. A new art room has also been added. The Brewers' Company have provided the funds for building, and the London Technical Education Board those for furnishing.

The will of Mr. H. W. Massey, of Toronto, contains numerous bequests to charities and educational institutions. Among the latter are 50,000 dols. to the American University at Washington, for a building to bear his name; 10,000 dols. to the Alma Ladies' School at St. Thomas; 100,000 dols. to the University of Mount Allison at Sackville, N.B.; 50,000 dols. to the Wesleyan Theological College at Montreal; 200,000 dols. to the University of Victoria, Toronto; 100,000 dols. to the Wesleyan College of Winnipeg, Manitoba.

We learn from the *Lancet* that Glasgow University is to receive under the will of the late Dr. John Grieve the sum of £8000, which is to be applied at the discretion of the court to the foundation of a lectureship, fellowship, or scholarship. The present demand for teaching in the subject of public health is very inadequately met by the existing laboratory arrangements, and the University Court has decided to equip a temporary laboratory until more satisfactory permanent dispositions are possible. Some recent communications with possible benefactors of the University render it probable that a lectureship in geology will shortly be instituted.

As we reported in our issue of February 20 of this year, it was decided by the County Council of Hampshire that the Finance and Technical Education Committees should meet together and report to the next meeting of the Council their opinion upon the manner in which the balance remaining after the annual expenditure on technical education had been defrayed, should be dealt with. At the meeting of the Council held on Monday, the 11th inst., the joint Committees reported that as an Education Bill had been introduced into Parliament dealing with the Local Taxation (Customs and Excise) Duties, they were of opinion that it would be undesirable to proceed with their deliberations. The report of the Technical Education Committee showed that good work had been done in the county during the past session.

On Saturday, May 2, the new grounds of Columbia University were dedicated, and the corner-stones of Physics Hall and Schermerhorn Hall were laid. A large and distinguished company gathered to honour the events, among whom were the Governor of the State and the Mayor of the City of New York. Congratulations were sent by the President of the United States. The new grounds comprise about seventeen acres, commanding a fine view of the Hudson, and very near to and in sight of the tomb of General Grant. The site is that of the Battle of Harlem, fought September 16, 1776. On this site a group of buildings are now rising, which will provide admirably for the University, giving it facilities unrivalled by any other in America. Its endowment also places it in the front rank. The University has productive property in New York City valued at twelve million dollars, besides large endowments of personal property. Several of the new buildings are gifts—the library from the President of the University, Seth Low, Schermerhorn Hall from William C. Schermerhorn, and the Havemeyer building from the Havemeyer family. University Hall is to be built by gifts from alumni of the University.

The Johns Hopkins University is only twenty years old, yet as regards excellence of work it ranks high among the leading universities in the world. A little brochure containing an account of the constitution and growth of the University has been published in commemoration of the recent twentieth anniversary. The fact that contributions amounting to more than a million of dollars have been received, is an indication that the foundation is firmly established in the confidence of the public. Nearly three thousand students have been instructed; three hundred of the graduates have been teachers in universities, colleges, and high schools, and altogether eight hundred persons who have been pupils of the University have been engaged in teaching; in fact, nearly every university and college in America numbers among its faculty a student of Johns Hopkins University. Since its opening, the University has encouraged the publication of the results of advanced scientific research. Several journals have been regularly maintained, and support has been given to many separate works. Among the most important serial publications are the *American Journal of Mathematics*, *American Chemical Journal*, *American Journal of Philology*, *Studies from the Biological Laboratory*, *Memoirs from the Biological Laboratory*, *Journal of Experimental Medicine*, and the *Johns Hopkins University Circulars*. Many separate publications have also been issued under the auspices, or with the aid, of the University, among the most noteworthy of these being Prof. Rowland's "Photographs of the Normal Solar Spectrum," "The Oyster in Maryland" (a publication in popular form of Prof. Brooks' investigation of the oyster and its relation to interests of Maryland), "Embryology of Insects and Arachnids," by Adam T. Bruce, "Geology and Physical Features of Maryland," by G. H. Williams and W. B Clark, Bulletins and Reports of various departments of the Johns Hopkins Hospital, and a number of topographical and geological maps. For the study of the marine fauna of the Chesapeake region, including the oyster, the Chesapeake Zoological Laboratory, or Marine Station, was instituted in 1878, and a considerable sum of money annually appropriated for its maintenance. Further, the University annually nominates a scholar to occupy a table at Wood's Holl Biological Laboratory, for the prosecution of biological investigation. Thus in a variety of ways the University has fostered original research and sound instruction, and has therefore contributed to the welfare of Baltimore and the advancement of science.

SCIENTIFIC SERIALS.

American Meteorological Journal, April 1896.—A speculation in topographical climatology, by Prof. W. M. Davis. The author refers to certain relations between existing topographic features and climatic conditions, the study of which enable us to infer the vanished climates of the past by means of their still-preserved topographic products. He discusses at some length the records of arid and humid climates, the consequences of various glacial theories, &c., and suggests an exploration of the most critical regions by well-trained topographical climatologists, with the points at issue clearly in mind.—The new meteorological observatory on the Brocken, by A. L Rotch. This observatory has an elevation of 3750 feet above the sea and is the highest mountain in Northern Germany. Observations, with some interruptions, were made between 1836 and 1869, and have now been resumed under the superintendence of the Prussian Meteorological Institute. The greatest difficulty in securing continuous observations is the frost, owing to which an anemometer cannot be kept in action, and much trouble is experienced with thermometers and rain-gauges; nevertheless, in addition to automatic records, direct observations are made thrice daily, from which important contributions will be added to our knowledge of the upper air. Further particulars of the work at this station will be found in *Die Natur* of the 26th ult. by Herr Koch, the Superintendent.

Bollettino della Società Sismologica Italiana, vol. i., 1896, No. 10 and 11.—Summary of the principal eruption phenomena in Sicily and the adjacent islands during the four months September to December, 1895, by S. Arcidiacono. For the whole year (1895) the following summary is given. Etna was covered by clouds on forty-six days; of the remainder, it was in a state of "emanation" on 172 days, and in a "strombolian" condition on 147 days. In Vulcano, Stromboli, and Salsi di Paternò, no change has occurred except that, on March 29, Stromboli passed from the normal to the explosive phase, at the same time a sensible earthquake was felt at several places in Calabria. On a new type of seismometrograph, by G. Agamennone. The instrument consists of a pendulum of mass 200 kg. and length 16 metres, whose movements are magnified by the light horizontal lines at right angles to one another. When the first tremor occurs, the velocity of the strip of paper is increased from about 30 cm. per hour to about 5 mm. per second. The instrument is installed in the Central Meteorological and Geodynamical Office at Rome.—Notices of Italian earthquakes (August-October 1895), the most important being the Adriatic earthquake of August 9.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, May 8.—Captain Abney, President, in the chair.—Messrs. Frith and Rogers read a paper on the true resistance of the electric arc. It was pointed out by Prof. Ayrton, at the British Association meeting at Ipswich, that if the "true resistance" of an arc is defined as the ratio of a small increase of the P.D. between the carbons to the corresponding change in the current, it follows that this "true resistance" must be a negative quantity. In order to measure the "true resistance" without appreciably altering the form of the carbons, &c., the authors superpose a small alternating current on the main continuous current. The arc lamp employed was adjusted by hand, and the arc length was measured by projecting an image of the arc by means of a lens. The main (continuous) current and P.D. were measured by a Weston ammeter and voltmeter, while the auxiliary alternating current was measured by means of an air transformer and an electrostatic voltmeter. The authors find that between the limits employed the magnitude of the alternating current did not influence the results obtained for the resistance of the arc. The frequency, so long as it lies between the limits 250 – 7 complete alternations per second, and the wave form, do not influence the resistance, since the same results were obtained with a Pyke and Harris alternator, a Ferranti alternator, a Gramme alternator, and a Mordey transformer. For each make of carbon examined, four combinations were used :— + cored, – cored : + cored, – solid ; + solid, – cored ; + solid, – solid. The general characteristic of the curves obtained is that for the + solid, – solid combination the "true resistance" is always negative ; while for + cored, – cored it is always positive ; the other curves lying between these two extremes, those which have the + carbon solid always being more negative than those which have the + carbon cored. In the case of the curves showing, for solid carbons, the relation between the resistance of the arc and the P.D. between the carbons, the current being constant (10 amperes), a minimum (maximum negative) value for the resistance occurs at about 55 volts. With combinations having a cored positive this minimum becomes more strongly marked, and occurs at a lower voltage. The authors find that for cored carbons the position of this minimum is closely connected with the presence or absence of the dark space in the arc. For points on the curve to the right of the minimum point, the dark space is absent ; while for points to the left of the minimum, the dark space is always present. It was found that the effect of using as the + carbon a Carré carbon in which the core had been bored out, was to obtain a curve closely resembling that obtained when both carbons were solid. On filling this hollow carbon with plaster of Paris or kaolin, the resistance of the arc became positive. The above experiments were made with the + carbon uppermost ; other experiments, made with the arc inverted, showed that with solid carbons the resistance is not appreciably altered by inverting the arc. With cored carbons, however, the resistance, as well as the physical character of the arc, is altered ; since, on inversion, the dark space disappears, and the resistance considerably diminishes. If, however, the conditions under which the arc is burning are such that the dark space is absent, then inverting the arc does not alter the resistance. Attempts were made to measure the "true resistance" of a direct current hissing arc, but it was found that, even with the alternator at rest, there was a large deflection of the electrometer, showing that the current through a hissing arc was oscillatory. In order to elucidate the marked difference between their results for cored carbons and those deduced from Mrs. Ayrton's curves, the authors have made a series of measurements at low frequencies. They find that there is a critical frequency above which the resistance has a positive value which is independent of the frequency, and below which it has a negative value, this critical frequency lying between 7·5 and 0. In order to investigate the sign of the resistance at low frequencies, the vibrations of the needles of the ammeter and voltmeter were made use of. By an arrangement of mirrors, the needles and scales of both instruments could be observed simultaneously. In this way it could be seen whether the two needles were, at any instant, vibrating in the same or in opposite directions. If the needles vibrate in the same phase, *i.e.* if an increase of P.D. is accompanied by an increase of current, then the resistance must be positive ; while if they are vibrating out of phase, *i.e.* if an increase of P.D. is accompanied by a decrease in current, then the resistance is negative. An attempt to run the arc off a continuous-current dynamo failed, since even with the alternator at rest the electrometer showed a large deflection, evidently due to the oscillation of the current, owing to the commutator of the dynamo having a finite number of segments. Prof. A. Gray doubted whether it was right to give the name "true resistance" of the arc to the slope of the curve connecting the potential difference (V) and the current (A). The authors' method of deducing $\delta V/\delta A$ was only true if the curve was a straight line ; while in the case of the arc, E and a may both vary with the current. Mrs. Ayrton said, that with reference to the question of the existence of a back E.M.F. the evidence tended to show that it did not exist. By using an exploring carbon, no constant back E.M.F would be found. Prof. Ayrton said, that considering the arc as consisting of a back E.M.F. and a resistance, it was necessary to separate these two. Simply obtaining one value of the P.D. and the current was of no assistance in solving this question, but a series of values had to be taken. By taking the change in P.D and current sufficiently small, the curve over the range considered was practically straight. It was curious to note that as long as observers obtained a positive value for the resistance of the arc, no fault was found with the method ; but that now a negative value was found, the accuracy of this method was questioned. If a back E.M.F. does really exist, then it follows that the arc must have a negative resistance. Mr. Frith has shown why some people have got positive and some negative values for the resistance of the arc, and also that with an alternating current you may get either one or the other. Mr. Tremlett Carter asked if the fact that the arc had a negative resistance did not imply a back E.M.F. in order that the arc might be stable. If so, was a negative resistance such an absurdity? Mr. Campbell said he was very pleased to see that the authors had applied a method which he (Mr. Campbell) had suggested for measuring pulsating currents. If a pulsating current, such as could be obtained by means of a make and break, were passed through a thermopile, you would get a back E.M.F. ; while if an alternating current were employed, you would not. Mr. Frith, in his reply, said that he had *defined* the "true resistance" as dV/dA. Mrs. Ayrton has shown that an arc will not run unless a certain resistance is placed in series with it ; this resistance must be numerically equal to the negative resistance of the arc itself. Prof. Ayrton said Mr. Frith's remarks as to the cause of the want of stability of an arc without outside resistance, were most suggestive. The Chairman (Captain Abney) said he did not like the expression P.D. He suggested the employment of photography to facilitate the accurate registration of the instrument readings. The further discussion on the paper was adjourned to the next meeting on May 22.

Mathematical Society, April 23.—Major MacMahon, R.A., F.R.S., President, in the chair.—The President communicated a portion of the following abstract of a paper by Prof. W. Burnside, F.R.S., on the isomorphism of a group with itself. A one-to-one correspondence between the operations of a group, which leaves the multiplication table of the group unaltered, is spoken of as an isomorphism of the group with itself. Such a correspondence may clearly be represented as a substitution performed on the symbols of the operations of the group, *i.e.* the isomorphism may itself be regarded as an operation, and the totality of the isomorphisms of a given group will themselves form a group. This group is known as the "group of isomorphisms" of the given group. The only general theorems connected with the isomorphism of a group with itself hitherto published are due to Herr O. Hölder[1] and Herr G. Frobenius.[2] In the first part of the present paper I have reproduced such of the definitions due to Herren Hölder and Frobenius as are necessary to render it self-contained, and also one fundamental theorem. An isomorphism is defined to be cogredient or contragredient according as it can or cannot be obtained by transforming all the operations of the group by one of themselves. The theorem is that the cogredient isomorphisms form a self-conjugate sub-group of the complete group of isomorphisms. A definition, due to Herr Frobenius, involving an important new conception, is that of a characteristic sub-group. It is as follows. If a sub-group of a given group is transformed into itself by every isomorphism of which the given group is capable, the sub-group is called a characteristic sub-group. In the second part I have first

[1] *Cf.* The first ten pages of a memoir with the title "Bildung Zusammengesetzter Gruppen." *Math. Ann.*, xlvi.

[2] *Cf.* Parts of memoirs with titles "Ueber Endliche Gruppen" and "Ueber auflösbare Gruppen II." *Berliner Sitzungsberichte*, 1895.

investigated the conditions under which a group should have no characteristic sub-group. This condition is that the group should be generated by a number of holohedrically isomorphous simple groups, such that every operation of any one of them is permutable with every operation of all the rest; or, in the phraseology of Herr Hölder, the group must be the direct product of a number of holohedrically isomorphous simple groups. The following theorem is then proved. If G is a group which has no characteristic sub-group, and if R is the group of greatest order that contains G self-conjugately, while at the same time no operation contained in R, and not in G, is permutable with every operation of G; then the group R admits of no contragredient isomorphisms, and contains no self-conjugate operation except identity. A special case of this theorem is that the group defined by the congruences

$$\begin{aligned} x_1^1 &\equiv \alpha_{11}x_1 + \alpha_{12}x_2 + \ \ldots \ + \alpha_{1n}x_n + \beta_1, \\ x_2^1 &\equiv \alpha_{21}x_1 + \alpha_{22}x_2 + \ \ldots \ + \alpha_{2n}x_n + \beta_2, \quad (\text{Mod. } \lambda, \text{ prime}) \\ &\ldots\ldots\ldots\ldots \\ x_n^1 &\equiv \alpha_{n1}x_1 + \alpha_{n2}x_2 + \ \ldots \ + \alpha_{nn}x_n + \beta_n, \end{aligned}$$

dmits only cogredient isomorphisms. In the third part I consider the group of isomorphisms of certain simple groups, some of whose properties I have already dealt with in vol. xxv. of the Society's *Proceedings*. For the simple group of order $2^n(2^{2n}-1)$ there defined, I show that the order of the group R of isomorphisms is $2^n(2^{2n}-1)n$, and that if H is the group of cogredient isomorphisms, the factor group R/H is a cyclical group of order n. For the simple groups of order $\frac{1}{2}\lambda^n(\lambda^{2n}-1)$, λ an odd prime, it is shown that the order of the group R of isomorphisms is $\lambda^n(\lambda^{2n}-1)n$, the factor group R/H being the direct product of cyclical groups of orders 2 and n. The latter class includes as a special case, $(\lambda^n = 3^2)$, the alternating group of six symbols. In Herr Hölder's paper, referred to above, the isomorphisms of the alternating group are dealt with, and, as compared with all other degrees, it is found that the alternating group of degree 6 behaves exceptionally, and requires rather elaborate treatment. There seems, however, to be no reason for regarding the alternating groups of different degrees as a set of groups which are characterised by common group-properties in the same way, for instance, as the groups of the modular equation for different prime transformations are; and this view is borne out by the fact that there is nothing exceptional in the behaviour of the alternating group of degree 6 when regarded as one of the class of groups here considered. —The President also read an abstract of a paper on division of the Lemniscate, by Prof. G. B. Mathews.—Dr. Hobson, F.R.S., read a paper on some general formulæ for the potentials of ellipsoids, shells, and discs.—The President offered some remarks on the compensation for difference of capital in gambling *à outrance*, being a contribution to the theory of the "Duration of Play."—Mr. Basset, F.R.S., read a paper on the stability of a frictionless liquid and the theory of critical planes. In the theory of the stability of the steady motion of a frictionless liquid which is bounded by the parallel planes $y=0$ and $y=a$, the disturbed motion depends upon the equation

$$(n/k + U)(d^2v/dy^2 - k^2v) = vd^2U/dy^2 \quad . \quad . \quad . \quad . \quad (1)$$

The usual process of solution fails whenever there is a plane, called a *critical* plane, at which $n/k + U = 0$, and the object of this paper is to examine the nature of the solution when such a plane exists. In steady motion $U = \phi(y)$, where ϕ is a given function; and if a critical plane exists, $-n/k = \phi(c)$, which determines the relation between the time-constant n and the wave-constant k, provided a *real* value of c can be found which lies between 0 and a. The integral of (1) is of the form

$$v = \mathrm{A}f_1(y) + \mathrm{B}f_2(y).$$

The boundary conditions require that $v=0$ when $y=0$ and $y=a$. At a critical plane $d^2U/dy^2=0$ or $v=0$. If the first condition is satisfied, and if neither of the functions f become infinite between $y=0$ and $y=a$, the boundary conditions enable the constants A and B to be eliminated, which leads to a relation of the form $F(a, k, c)=0$, and the conditions for the existence of a critical plane require that this equation should furnish at least one *real* value of c lying between 0 and a. But if one of the functions—say f_2—becomes infinite between the limits, $B=0$, and the boundary conditions cannot usually be satisfied, in which case a critical plane cannot exist. When the form of U is such that d^2U/dy^2 does not vanish when $y=c$, a critical plane cannot exist except in very special circumstances. The paper concludes by showing that the particular solutions obtained by the hypothesis that x and t enter into the solution in the form of the factor $\epsilon^{\iota kx+\iota nt}$ can always be generalised by Fourier's theorem, so as to include every possible disturbance which does not violate the boundary conditions. The author and Mr. Love, F.R.S., joined in a discussion on the subject of the communication.

Geological Society, April 29.—Dr. Henry Hicks, F.R.S., President, in the chair.—Descriptions of new fossils from the carboniferous limestone. (1) On *Pemmatites constipatus*, sp. nov., a lithistid sponge. (2) On *Palæacis humilis*, sp. nov., a new perforate coral; with remarks on the genus. (3) On the jaw-apparatus of an Annelid, *Eunicites Reidii*, sp. nov., by Dr. G. Hinde.—(1) The *Pemmatites*, belonging to genus hitherto only known from the Permo-Carboniferous beds of Spitzbergen, was discovered in the Yoredale beds of Yorkshire by Mr. J. Rhodes, and is the only fairly complete sponge which has hitherto been detected in the Yoredale beds of North-west Yorkshire. The author gave a full description of the species. (2) The *Palæacis* was found by the Rev. G. C. H. Pollen in the carboniferous limestone and shale series, on the banks of the Hodder, near Stonyhurst. The specific characters of the form were given by the author, who, in the light of the new information, gave a fresh definition of the genus *Palæacis*, which appears to represent a distinct family of perforate corals, in some features more nearly allied to the Favositidæ than to the Madreporidæ or Poritidæ. (3) The third specimen was discovered by Miss Margery A. Reid in the Lower Carboniferous beds of Halkin Mountain, Flintshire, and is named in honour of its discoverer. A description of it was given, and it was stated that, notwithstanding certain peculiarities, the individual pieces correspond so closely with those of the recent *Eunice* family that it may well be included in the genus *Eunicites*.—The Eocene deposits of Dorset, by Clement Reid. The new survey of the western end of the Hampshire basin shows that the Reading beds become fluviatile and gravelly in Dorset (as was already known), and contain, in addition to chalk flints, many fragments of Greensand chert. The London clay thins greatly and becomes more sandy, but is apparently still marine. The Bagshot sands become coarser and more fluviatile, changing rapidly west of Moreton Station, till they consist mainly of coarse subangular gravel. These gravels, formerly referred to the Reading series, are now shown to be continuous with the Bagshot sands, which as they become coarser cut through the London clay and Reading beds to rest directly on the chalk. The Bagshot gravels contain, besides chalk flints and Greensand chert, fragments of Purbeck marble and numerous Palæozoic grits and other stones probably derived from the Permian breccias of Devon.—Discovery of mammalian remains in the old river-gravels of the Derwent near Derby, Part i., by H. H. Arnold-Bemrose. A few mammalian bones were found in sinking a well at Allenton. On April 8, 1895, the authors commenced further excavations, and were successful in finding a number of bones of a *Hippopotamus*, an *Elephas*, and of a *Rhinoceros*. They were found in a dark-coloured sand above the river-gravel, at a depth of 9 feet 8 inches below the surface. Mr. Clement Reid found some twenty or more species of plant-remains in the sand. These plants "indicate a moist meadow or swampy ground, and a temperate climate. The species are all widely distributed." Part ii., by R. M. Deeley. The deposits in which the bones were found occupy a wide trench which occurs on the inside edge of a gravel-terrace stretching for several miles south of Derby, at a height of 15 or 20 feet above the modern alluvial plain. The gravels are of later age than the great chalky boulder clay, and were formed at a time when the rivers were removing from their preglacial valleys the older boulder clays, with which they had been partially filled. Gravels of two ages are recognised: (*a*) recent gravels well stratified, undisturbed, and covered in many places by a thick layer of brick-earth; and (*b*) high-level gravels showing "trail" and contorted bedding. It is in these latter gravels that the trench containing the mammalian remains occurs.

Zoological Society, May 5.—Dr. John Anderson, F.R.S., Vice-President, in the chair.—Mr. W. E. Hoyle exhibited a Röntgen-ray photograph of a snake in the act of swallowing a mouse.—Mr. G. A. Boulenger, F.R.S., read a paper on some little-known Batrachians from the Caucasus, based chiefly on specimens recently transmitted to the British Museum by Dr. Radde, of Tiflis. Among these was an example of the new frog of the genus *Pelodytes*, for which he had proposed the name *P. caucasicus*. Altogether ten species of Batrachians

were now known from the Caucasus.—Mr. F. E. Beddard, F.R.S., read the second of his contributions to the anatomy of Picarian birds. The present communication related to the pterylosis of the *Capitonidæ*.—Mr. M. F. Woodward read a paper on the dentition of certain Insectivores, and pointed out that there was strong evidence to show that the milk-dentition was undergoing reduction in this group as a whole, some of the milk-teeth in *Erinaceus* and *Gymnura* being present as small calcified tooth-vestiges only, while in *Sorex* there were apparently no calcified milk-teeth, but only vestigial milk-enamel organs.—A communication from Mr. A. D. Bartlett contained some notes on the breeding of the Surinam Toad (*Pipa americana*,) as recently observed in the Society's Gardens. It had been observed that the eggs when issued from the cloaca of the female, which was protruded into a bladder-like process during their production, were arranged on the back of the female by the action of the male.

Anthropological Institute, May 12.—Mr. E. W. Brabrook, President, in the chair.—Mr. H. W. Seton-Karr exhibited and made remarks on a collection of stone implements discovered by him in Somaliland. Sir John Evans, Prof. Rupert Jones, and Mr. C. H. Read spoke and complimented Mr. Seton-Karr upon his discovery.—Dr. J. G. Garson read a paper on recent observations on the Andamanese by Mr. M. V. Portman. A discussion followed, during which remarks were made by Sir William Flower, Prof. Keane, Mr. C. H. Read, and Prof. Brigham of Honolulu. Dr. Garson read another paper on photographic apparatus for travellers, and exhibited a number of cameras of various designs.

EDINBURGH.

Royal Society, May 4.—Prof. M'Kendrick in the chair.—Dr. John Macintyre made a further communication describing new results with the X-rays. Some of these have already appeared in NATURE (vol. liii. p. 614). He found that his coil gave better results when a mercury interrupter was used, and, on regulating this to give one flash in the tube, he was struck by the peculiar colour of the discharge. He exhibited a photo of the hand taken with one flash, which was quite distinct. With ten flashes it was excellent. What the exposure would be in the case of one flash, he could not say. He had tried the effect of the rays on tourmaline, but could find no trace of polarisation. Prof. M'Kendrick said he had satisfied himself that the rays had no effect on the electric phenomena of the pulsating heart, nor on the motor nerves, but that they had an influence on the currents referable to the retina.—Dr. J. C. Dunlop read a paper on the action of acids on the metabolism. He showed them to have a marked diuretic action, to affect the acidity of the urine only slightly, the acidity being to a great extent neutralised by an increased alkali excretion, and to produce an increased excretion of nitrogen as pre-formed ammonia and extractives, but not as urea. His results did not agree with those of Dr. Haig in the same field.—The Secretary read a paper on clouds, by Mr. John Aitken.—Dr. C. G. Knott read a paper by Prof. J. M. Dixon, on a graphical representation of emotion as expressed in rhythm. The author plotted a graph of the number of syllables in each stanza of Browning's "Abt Vogler," and endeavoured to deduce from the graph the variations in Browning's feelings. Other specimens were treated similarly.

PARIS.

Academy of Sciences, May 11.—On the *rôle* of the induction ring of iron in dynamo-electric machines, by M. Marcel-Deprez. A discussion as to the cause of the effect produced by the ring of iron in dynamos of the Pacinotti type. Some experiments are cited which tend to show that the explanations usually given in text-books are insufficient. The complete theory will be given in a future paper.—Nitrates in potable waters, by M. Th. Schlœsing. The results are given of a large number of determinations of nitrates and of calcium in potable waters from various sources. Curves are given showing the variations of these with the season.—On the crepuscular phenomena, and the appearance of the dark face of Venus, by M. Perrotin.—On regular non-linear substitutions, by M. Antoine.—An elementary demonstration of a theorem of M. Picard on complete functions, by M. E. Borel.—Remarks on the preceding communication, by M. Picard.—On the periodic solutions of the problem of the movement of a body suspended by one of its points, by M. G. Kœnigs.—On the rotation of solids and Maxwell's principle, by M. R. Liouville. An examination of a case for which Maxwell's principle does not hold good.—Observations concerning the note of M. Dongier on a method of measuring double refraction, by M. G. Friedel. It is pointed out that the method of M. Dongier was anticipated by the author in 1893.—On the lowering of the explosive dynamic potential by ultra-violet light, and the interpretation of certain experiments of M. Jaumann, by M. R. Swyngedauw. The study of the influence of the rate of variation of potential upon the explosive potential must be made in the absence of ultra-violet light. The neglect of this precaution vitiates the results obtained by M. Jaumann.—On the condensation of dark light, by M. G. Le Bon. Two plates of metal (copper and lead), after exposure to an electric arc for an hour, were made to enclose a negative and a sensitive plate, the faces that had not been exposed to the light being inwards. Precautions were taken to eliminate the possible effects of heat and of contact. That the resulting image must have been caused by something stored on the surface of the metal plates during the exposure to the arc lamp, was definitely proved by the negative results of parallel experiments with plates not exposed to the arc lamp.—The action of hydrogen bromide upon thiophosphoryl chloride, by M. A. Besson (see Notes, p. 63).—The action of air and of peroxide of nitrogen upon some halogen compounds of bismuth, by M. V. Thomas. The halogen compounds studied included the tribromide, triiodide, and the dichloride, which yielded as ultimate products bismuth oxybromide, bismuthic oxide, and bismuth oxychloride respectively.—Action of ethyl-oxalyl chloride upon the aromatic hydrocarbons in presence of aluminium chloride, by M. L. Bouveault. Under suitable conditions this reaction readily results in the production of ethyl phenyl-glyoxylate, or its derivatives.—On a new method of separating the methylamines, by M. Marcel-Delépine. The mixture of amine hydrochlorides is boiled with caustic soda, and the gases passed into commercial formaldehyde. This distillate is now heated with caustic soda, and, after drying, submitted to fractional distillation. Three principal fractions are obtained, at 15°–20°, 67°–68°, and 166° C. The first is trimethylamine, and the two latter, on heating with alcoholic hydrochloric acid, yield the pure hydrochlorides of dimethylamine and methylamine. The separation is more perfect than in the classical method with ethyl oxalate.—On the Synascidia of the genus *Colella*, and the polymorphism of their buds, by M. Maurice Caullery.—On the nephridia of *Branchiobdella varians* (var. *Astaci*), by M. D. N. Voinov.—Formation of an anti-coagulating substance by the liver in presence of peptone, by M. C. Delezenne.—On the effects produced on certain animals by the toxins and anti-toxins of diphtheria and tetanus injected into the rectum, by M. P. Gibier. Toxins and anti-toxins injected *per rectum* are without any effect, and appear to be destroyed or retained by the rectal mucus. For the animals used in the experiments (rabbit, dog, and guinea-pig), the toxins did not poison, and the anti-toxins conferred no immunity.—Hydrographical researches of M. Spindler in Lake Peypous, by M. Venukoff.

PHILADELPHIA.

Academy of Natural Sciences, March 31.—Prof. Henry A. Pilsby called attention to a fine collection of barnacles obtained from the bottom of a vessel recently returned from a voyage to Hong Kong from San Francisco and back, by way of Java and India. *Balanus tintinabulum* was the commonest of the species represented, the varieties *zebra* and *spinosus*, although growing under identical conditions, retained their individuality perfectly.—The question of the constancy of varietal characters was debated by Messrs. Sharp, Pilsby, and Heilprin.—Mr. Pilsby also described a specimen of *Pugnus parvus*, a ringiculate mollusc. The species is involute, a unique character, none of the fossil forms of the family possessing it. He also described a Central American Melanian, under the name *Pachycheilus Dalli*. It is distinguished by a remarkable double sinuation of the outer lip, which has a deep and wide pleurotonoid sinus above, and a rounded projecting lobe in the middle, below which it is again retracted.—On the nomination of the Entomological Section, Dr. Henry Skinner was elected Professor in the Department of Insecta. In response to an invitation from the Committee having charge of the celebration of the fiftieth year of Lord Kelvin's tenure of office as Professor of Natural Philosophy in the University of Glasgow, General Isaac Jones Wistar was appointed to represent the Academy on the occasion.

March 25.—Dr. George H. Horn made a communication regarding the synonymy of the Elateridæ. He specially described the prosternum of Ludius. A Lower California form had the pro-

sternum of different shape from that of other members of the genus, the mesosternum being more protuberant. It will probably be referred to Probothrium.—Mr. Chas. S. Welles exhibited specimens of the larva of *Harrisimemna trisignata*. When full-grown they bore into wood preparatory to changing into chrysalids.—A paper was read entitled "The breeding habits of *Periplaneta orientalis*," by C. Few Seiss. Three females deposited twenty-five egg-cases. Each of these contains sixteen eggs, so that a new generation of 400 cockroaches was represented by the deposit. The first of these egg-cases were dropped May 5 and May 14, 1895, and were hatched November 9. In most cases the deposits were dropped with no attempt at concealment, although in a few instances they were placed in little trenches made by the insect, and then covered up. The development of the capsules was described. The young, probably, receive no maternal care or protection.—Mr. Lancaster Thomas exhibited an improved form of insect net-frame made from a continuous piece of rounded aluminium wire.—Mr. Westcott suggested linoleum as a substitute for cork in the arrangement of insects.—Dr. Henry Skinner called attention to a fungus, *Polyporus betulinus*, which might be used for the same purpose with advantage.—Mr. William J. Fox stated that about ninety species of Hymenoptera, six of which were perhaps new to science, were included in the collections of insects brought by Dr. A. Donaldson Smith from Western Somaliland, Africa.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, MAY 21

ROYAL SOCIETY, at 4.30.—On the Changes produced in Magnetised Iron and Steels by cooling to the Temperature of Liquid Air: Prof. J. Dewar, F.R.S., and Dr. J. A. Fleming, F.R.S.—Note on the Larva and of the Post-Larval Development of Leucosolenia variabilis, H. Sp., with remarks on the Development of other Asconidæ: E. A. Minchin.—Helium and Argon. Part III. Experiments which have yielded Negative Results: Prof. Ramsay, F.R.S., and Dr. Collie.—On the Amount of Argon and Helium contained in the Gas from the Bath Springs: Lord Rayleigh, Sec.R.S.

ROYAL INSTITUTION, at 3.—The Art of Working Metals in Japan: W. Gowland.

CHEMICAL SOCIETY, at 8.—The Diphenylbenzenes. I. Metadiphenylbenzene: F. D. Chattaway and R. C. T. Evans.—Derivatives of Camphoric Acid: Dr. F. S. Kipping.—Some Substances exhibiting Rotatory Power, both in the Liquid and Crystalline states: W. J. Pope.

FRIDAY, MAY 22.

ROYAL INSTITUTION, at 9.—Hysteresis: Prof. J. A. Ewing, F.R.S.

PHYSICAL SOCIETY, at 5.—On Dielectrics: R. Appleyard.—The Field of an Elliptical Current: J. Viriamu Jones.—An Instrument for Measuring Frequency: A. Campbell.

SATURDAY, MAY 23.

GEOLOGISTS' ASSOCIATION (Paddington, at 11.45).—Excursion to Chippenham, Calne, Kellaways, and Corsham.

YORKSHIRE NATURALISTS' UNION, at Hellifield.—Four Days' Excursion for the investigation of Bowland.

MONDAY, MAY 25.

LINNEAN SOCIETY, at 3.—Anniversary Meeting.

TUESDAY, MAY 26.

ROYAL INSTITUTION, at 3.—The Building and Sculpture of Western Europe: Prof. T. G. Bonney, F.R.S.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Apparatus for Photography on Small Plates (smaller than Quarter Plates).

WEDNESDAY, MAY 27.

GEOLOGICAL SOCIETY, at 8.—On the Pliocene Deposits of Holland, and their relation to the English and Belgian Crags, with a Suggestion for the Establishment of a New Zone—"Amstelien"—and some Remarks on the Geographical Conditions of the Pliocene Epoch in Northern Europe: F. W. Harmer.—The Lingula-Flags and Igneous Rocks of the Neighbourhood of Dolgelly: Philip Lake and S. H. Reynolds.—The Kildare Inlier: C. J. Gardiner and S. H. Reynolds.

BRITISH ASTRONOMICAL ASSOCIATION, at 5.

THURSDAY, MAY 28.

ROYAL INSTITUTION, at 3.—Lake Dwellings: Dr. Robert Munro.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Utilisation of Water-Power, especially with a Small Fall, with some Examples of Plants for the Generation of Electrical Energy: Alph. Steiger.

CHEMICAL SOCIETY, at 8.—Lothar Meyer Memorial Lecture: Prof. P. Phillips Bedson.

SATURDAY, MAY 30.

ROYAL INSTITUTION, at 3.—The Moral and Religious Literature of Ancient Europe: Dr. E. A. Wallis Budge.

ROYAL BOTANIC SOCIETY, at 3.45.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Evolution of Bird-Song: C. A. Witchell (Black).—Meteorological Results of the Observations taken at the Bangalore, &c., Observatories, 1893-94: J. Cook (Bangalore).—Earth Knowledge: W. J. Harrison and H. R. Wakefield, Part 2 (Blackie).—The Flora of the Alps: A. W. Bennett, 2 Vols. (Nimmo).—Attaque des Places: Lieut.-Colonel E. Hennebert (Paris, Gauthier-Villars).—La Spectroscopie: Prof. J. Lefèvre (Paris, Gauthier-Villars).—Grundriss der Entwicklungsgeschichte des Menschen und der Sängethiere: Dr. O. Schultze, Erste Hälfte (Leipzig, Engelmann).—Southall's Organic Materia Medica: J. Barclay, 5th edition (Churchill).—Schlich's Manual of Forestry. Vol. v. Forest Utillzation: Prof. Fisher (Bradbury).—Water Supply: Prof. W. P. Mason (Chapman).—A Dictionary of the Names of Minerals: Prof. A. H. Chester (Chapman).—Leerboek der Organische Chemie: Dr. A. F. Holleman (Groningen, Wolters).—The Elements of Physics: E. L. Nichols and W. S. Franklin. Vol. I. Mechanics and Heat (Macmillan).—Memoirs of Frederick A. P. Barnard: J. Fulton (Macmillan).—Nature's Byepaths: Dr. J. E. Taylor. 6th edition (W. H. Allen).—The Aquarium: Dr. J. E. Taylor, 6th edition (W. H. Allen).—Mathematical Papers read at the International Mathematical Congress held in connection with the World's Columbian Exposition, Chicago, 1893 (New York, Macmillan).—Stanford's Compendium of Geography and Travel, new issue. Asia, Vol. 1: A. H. Keane (Stanford).—Gehirn und Seele: Dr. P. Flechsig (Leipzig, Veit).

PAMPHLETS.—Remarkable Eclipses: W. T. Lynn (Stanford).—The Old Light and the New: W. Ackroyd (Chapman).—Nineteenth Report of the State Entomologist on the Noxious and Beneficial Insects of the State of Illinois (Springfield, Ill.).

SERIALS.—Engineering Magazine, May (Tucker).—Science Progress, May (Scientific Press).—Strand Magazine, May (Newnes).—American Naturalist, May (Philadelphia).—Bulletin of the American Mathematical Society, April (New York, Macmillan).—Journal of the Chemical Society, May (Gurney).—Journal of the Royal Microscopical Society, April (Williams).—Astrophysical Journal, May (Chicago).—Royal Natural History, Part 31 (Warne).

CONTENTS.

THURSDAY, MAY 28, 1896.

THE PHOTOGRAPHY OF HISTOLOGICAL EVIDENCE.

An Atlas of the Fertilisation and Karyokinesis of the Ovum. By E. B. Wilson, with the co-operation of E. Leaming. (New York and London: Macmillan, 1895.)

PROF. WILSON has earned the gratitude of teachers and students of biology by publishing his "Atlas of Fertilisation." He has collected, on ten plates of a convenient size, a series of photographs illustrating the development of *Toxopneustes*, from the mature ovarian ovum until the formation of a sixteen-celled blastosphere. The photographs were made by Dr. Leaming, from sections prepared by Prof. Wilson; and they have been admirably printed from untouched negatives. Each figure is about three and a half inches in diameter, so that all details capable of photographic reproduction can be easily seen.

The first plate contains two photographs of ovarian eggs, in which the nuclear structure is well seen; a third, showing the nuclear division leading to the first polar body; and a fourth, showing the mature egg after extrusion of both polar bodies. The next four plates illustrate the entrance of the spermatozoön, the approximation of the male and female nuclei, and the formation of the "asters." The sixth plate shows the changes in the approximated nuclei during the pause which follows the entrance of the spermatozoon; and the seventh, eighth and ninth contain twelve very beautiful figures of the first division of the fertilised egg. Finally, some of the later divisions are exhibited on the tenth plate.

The photographs are accompanied by a short but clear account of the phenomena they are intended to illustrate; and in many cases difficult details are rendered intelligible by means of diagrams.

There can be no doubt that this Atlas will be of great service to students and to teachers, as an exposition of our present knowledge concerning the main facts of fertilisation; although one is tempted to regret the absence of any figures demonstrating the number of chromosomes, either in the polar bodies or the pronuclei. The excellence of the work suggests, however, another standard by which to judge it—a standard indicated by Prof. Wilson himself in his preface, when he points out that the most careful drawings involve a subjective element from which photographs are free, and states his belief that, in spite of certain necessary shortcomings, "the photographic plates here presented give, on the whole, a clear and accurate impression of the preparations."

If photography could indeed provide an image of histological preparations, as clear and accurate as that received by the eye of a trained observer, then a great step would have been made; for every histologist would be enabled to convey to others the whole evidence for his statements in a way before impossible; and a photograph, when once successfully taken, might serve as material for future research in the hands of men unable to procure the object photographed.

Unfortunately, Dr. Leaming's photographs, admirable as they are, do not approach the perfection necessary if they are to be regarded as representing the whole evidence given by the actual sections. This may easily be seen by any one who tries to determine from them the truth of some statements made in the text.

Prof. Wilson holds the view, now shared by the majority of observers, that both the centrospheres of the fertilised egg arise from a portion of the spermatozoon; and he considers that the male and female chromatin elements lie side by side, without mixing, during the division of the single original centrosphere. As evidence of this, he gives photographs 17, 18 and 19, and woodcuts xi. and xii. In the woodcuts, the distinction between the male nucleus and the female is clear and unmistakable; while, at least in photographs 18 and 19, this is not the case. Again, in the photograph fig. 19 there is no clear indication of structure in the male nucleus; while in the woodcut fig. xii. B, which may well have been drawn from the actual section photographed, a distinct reticulum is indicated in its substance.

Few persons will believe that Prof. Wilson has made positive statements on the evidence of sections showing no more than the photographs referred to: every one will feel that the woodcuts represent the essentials of his preparations better than the photographs. So that we have to judge the question, after all, by reading the author's account of what he says he saw; and when photography has done its best, the evidence of the condition of these nuclei at a particular moment still rests upon his reputation as a histologist, as completely as it would have done had he published the woodcuts only, or no figures at all.

In the case just referred to, the author's statement is so completely in accord with those of other workers, that few will hesitate to accept it; but when he points to photograph No. 19 as evidence that the rays of the amphi-aster "are really fibres, and not, as some recent authors have maintained, merely the optical sections of thin plates or lamellæ in a radially arranged alveolar structure," there is equally little evidence one way or the other to be obtained from the photograph, while there is more room for doubt as to the accuracy of the interpretation. The reference is, of course, to Bütschli's work on the structure of protoplasm; and those readers of NATURE who have compared Prof. Bütschli's photographs with his drawings, will remember that in his case also the photographic reproduction of the evidence was not a material addition to the strength of the argument.

On the whole, it seems certain that the best photograph at present possible does not show so much as can be seen by looking directly at a good histological preparation: so that it is not yet possible for a histologist to multiply copies of his evidence in a form from which the subjective element is altogether excluded. There is still no way of testing a histological statement without direct examination of the object described. Further, it seems that a careful drawing by a trained observer gives a better idea of appearances seen under the microscope than the best available reproduction by photography can at present achieve.

W. F. R. WELDON.

THE KEW INDEX OF PLANT NAMES.

Index Kewensis Plantarum Phanerogamarum. Sumptibus beati Caroli Roberti Darwin ductu et consilio Josephi D. Hooker confecit B. Daydon Jackson. Fasciculus iv. Pp. 641–1297. (Oxonii: e prelo Clarendoniano, 1895.)

THE serial issue from the press of large works of reference like that under notice does not always proceed with the rapidity which, to those whose appetites are whetted by foretaste, appears possible and desirable. It is therefore with all the more satisfaction that we chronicle the issue with commendable promptness of this, the fourth, fasciculus of the Kew Index, by which the work is brought to completion. Botanists and all who have concern in the names of plants are thereby furnished with a book which must always form an essential tool in their library equipment.

The appearance of the earlier fasciculi gave occasion for a notice in NATURE of the aim and scope of the work, and it is not necessary therefore to refer to these again, the less so as the two years that have elapsed since the first fasciculus came into our hands have sufficed to familiarise those who have need to use such a book with its value as a standard work of reference. It may not, however, be mistimed to repeat here the caution given by the Director of Kew in his address at the Ipswich meeting of the British Association, that the work is no more than its name signifies. It is a sound and safe guide; it is not a critical botanical work. The bulk of the names as cited in the Index may be regarded as definitely fixed for the nomenclature of botanists, at least in Great Britain; but throughout the volumes any one may find abundant evidence that it was not the intention of those who have laboured to produce this magnificent work to go beyond the identifications established in the literature of botany at the date at which their citations close. Further study and investigation must result in modifications of limits imposed by the state of botany in 1885, and names will change therewith; but such alterations of names, the acceptation or rejection of which must be a matter of botanical opinion, will not detract from, but will rather enhance the value of the Index as a standard of botanical nomenclature.

In no direction is the beneficent influence of the publication of the Index more immediately to be looked for than in the literature of horticulture, and it is in this aspect that the book will appeal to that large section of the public delighting in gardening, and which naturally objects to purchasing from a nurseryman the same plant over and over again under different names. It would appear that the Index is already exercising an effect, and that nurserymen are disposed to use the botanical name, if not instead of, at least cited alongside of, the trade name for plants in their catalogues—a practical result for which we cannot be too thankful, and in the hastening of which we must recognise the stimulus given by the excellent series of hand-lists of plants cultivated in the Royal Gardens, Kew, now in course of publication.

On the completion of their labours upon this vast work the botanical world will accord to Mr. Daydon Jackson and Sir Joseph Hooker its hearty congratulations, nor will it forget that to Mr Darwin it owes the projection and endowment of the book. To the Clarendon Press, too, its thanks will be given for the dress in which it has sent out the volumes. Whatever may be the future of botanical nomenclature—and the opening of the twentieth century is threatened with no less an infliction than a new "nomenclator," prepared in conformity with his own special principles by Dr. Otto Kuntze, which is to sweep away the nomenclature of the Kew, Berlin, and New York "cliques" (the productive seats of systematic botany)—botanists in all time must recognise the sound, judicious, conscientious workmanship displayed in the Index Kewensis through which it takes and will retain its value as a work of reference.

THE ANATOMY OF FEAR.

Fear. By Angelo Mosso. Translated from the fifth edition of the Italian, by E. Lough and F. Kiesow 8vo. Pp. 277. (London, New York, and Bombay: Longmans, Green, and Co., 1896.)

THE learned and eloquent Professor of Physiology at Turin has given us in the book which he has entitled "Fear," an analysis of this mental condition and its accompanying physical states, which, marked as it is by scientific accuracy and couched in charming and even in poetical diction, will take high rank as a popular exposition of our knowledge of the expression of one of the most interesting of the emotions of both men and animals. The extent of ground which is covered by the author, and the amount of information which he has contrived to convey within a small compass, excites our astonishment and admiration. Nor, in spite of the complicated scientific problems which are dealt with, is there a word of heavy reading from beginning to end. The book is beyond measure interesting, and one that when taken up it is difficult to lay down unread. Clearly it was impossible in a work with this title to avoid gruesome details, and readers whose nerves are disagreeably affected by descriptions of morbid conditions may put the book down with a shudder when they arrive at a passage in which a pathological case, which is used to illustrate the argument, is painted in glowing language from the life. For the author has in no wise burked such details; on the contrary, they come before one from time to time in the work with a vividness which transports one bodily to the hospital ward, the asylum, the vivisection table! But there is at the same time such a strong under-current of sympathy with suffering pervading the whole, that while the reader will come away from the scenes depicted, deeply interested in the lessons which they teach, there is no fear that he will be rendered callous by the familiarity which he has acquired with their horrors.

The idea of the book is to endeavour to rest the expression of this important emotion upon a physiological basis. With this aim in view, the effects of dread upon the heart and circulation, upon the respirations, upon the muscular system both voluntary and visceral, upon the secretions, and upon the central nervous system, are portrayed. Nor does the author confine himself strictly to the emotion which gives the book its

title, although this naturally constitutes the main theme. The number of other subjects incidentally treated of, furnishes a pleasing variety, and largely helps to maintain the interest of the reader, whether he be scientific or not. In pursuing his subject, Prof. Mosso is led into a criticism of Greek art, and contrasts as a medium of expression of the emotions the works of Phidias and Praxiteles with those of the schools of Pergamos and Rhodes. He compares the Niobe with the Laocoon; in the former he finds lacking "the expression of intense emotion, of horror, fear, and pain, which would inevitably be present in the terrible moment of so cruel a butchery."

"Though Praxiteles himself were the creator of the Niobean group, I yet hold that a humble physiologist, looking with dispassionate eye at these statues, may affirm that they fall short of the fame of so great a master, because the faces are not so modelled as to produce the desired effect, because nature is not faithfully copied, and because there lacks the sublime ideality of terror aroused by the chastisement of an offended deity, which was the subject of the work."

On the other hand, in spite of certain anatomica errors in the furrows of the brow in the Laocoon,

"an intense and majestic pain is written on the face, . . . one seems to hear the sigh of superhumân agony from his lips, and sees the lines of beauty and of pain wonderfully blended."

In touching upon questions of inheritance, the author shows himself rather a disciple of Spencer than of Darwin. But it is not clear upon what evidence he founds the statement that if two hounds of the same litter are taken, and one trained for sport and the other as a watch-dog, their offspring, after four or five generations of such training, although brought up under the same conditions and far from noise, will be in the one case excited, in the other terrified on first hearing the report of a gun. Nor I conceive will the assertion be generally accepted that the disappearance of the eyes in subterranean animals "is certainly not the result of natural selection, for eyes are not injurious even to beings living in the dark." On the other hand all will agree with the author in deprecating the installation of fear in the child, of which the ignorant mother or nurse is so often guilty.

"The children of ancient Greece and Rome used to be frightened with the lamias who would suck their blood, with the masks of the atellans, the Cyclops, or with a black Mercury who would come to carry them away. And this most pernicious error in education has not yet disappeared, for children are still frightened with the bogey-man, with stories of imaginary monsters, the ogre, the hobgoblin, the wizard and the witches."

"Children should be brought up as though they were rational. . . . The same methods should be followed in education as in the teaching of science . . . we should never issue any command without showing the reasons why it should be done in this way rather than in another." . . . "They must not be fatigued with study . . . even for healthy children premature education is a very grievous error."

"Parents who have already some weak spot—a little fault in the character, a slight blemish in the organism—should redouble their care in order to cure their children from their own defects. . . . The paramount object of education should be to increase the strength of man, and to foster in him everything which conduces to life. . . . We sometimes imagine that the most important branch of culture is that which we attain through education and study . . . but in ourselves, our blood, there is a no less important factor. . . . Fear is a disease to be cured; the brave man may fail sometimes, but the coward fails always."

The translation is excellent throughout.

E. A. SCHÄFER.

OUR BOOK SHELF.

Die Physiologie des Geruchs. (*The Physiology of Smell.*) By Dr. H. Zwaardemaker. Pp. 324. (Leipzig: Engelmann, 1895.)

VON HARTMAN, in defending himself against a friend who upbraids him for having wasted upon philosophy talents which might have been devoted to the accumulation of facts of positive science, points out in memorable words that facts of science are amassed only in order that they may be synthesised.

The critic is bound to remember this in appraising a book like that of Dr. Zwaardemaker's, for Dr. Zwaardemaker has added to the burden of physiological facts, and he has not established any generalisations to assist us in the carrying of that load.

If we overlook this fact, and we ought not to overlook it lightly, the work is a most praiseworthy one, a work that is characterised by the thoroughness which the Teuton strives after, and which, as a matter of fact, is found in the best of Low German science. There are very careful chapters in this book, only to mention a few, on the physical characteristics of odorous substances, on the mechanics of smell, on "olfactory" and "breath-fields," on the relations between taste and smell, on a new method of testing the acuity of smell, on the masking of smells by other smells, on the classification of smells, and on Prof. Haycraft's work on the relations between odour and chemical composition. Many of these subjects are treated with considerable originality. The "breath-field" is mapped out by breathing on a bright metallic surface. It is shown that two patches of dimness are produced, corresponding respectively to the right and the left nostril. It is further shown that each of these fields is subdivided into two smaller fields by a linear interspace, which in all probability corresponds to the inferior turbinated bone. The two patches of dimness on each side, therefore, in all probability correspond to the two streams of air which pass respectively above and below the lower turbinated bone. The patch of dimness which corresponds to the current of air which passes over the lower turbinated bone is conterminous with the olfactory field as determined by an independent method.

The apparatus for testing the acuity of smell consists of a porous clay cylinder, which is fitted up somewhat after the manner of a syringe. The piston-rod consists of a tube which serves to convey the air into the nostril. The air which is thus fed into the nostril consists in part of inodorous air which has been drawn in from without through the open end of the clay cylinder, and in part of air which has been in contact with the walls of the porous cylinder which has been impregnated with an odorous substance. The proportion of odorous to inodorous air can be varied at pleasure by regulating the position of the piston in the cylinder.

The chapter on the association between smell and taste emphasises the fact that there is an inlet to the olfactory chamber through the posterior nares, as well as through the nostrils. We therefore smell both when we inspire and when we expire. It is because he is ignorant of this fact that the layman is incredulous when he is

informed that many of the sensations which he refers to taste are in reality referable to smell, and it is on account of the same ignorance, that the child thinks he is treated irrationally when his nose is held while his castor-oil is being administered to him.

A few facts of this sort will be all that an ordinary reader will carry away from a perusal of this book. The book will be really valuable only to the physiologist who, like Dr. Zwaardemaker, is willing to devote himself to the study of the physiology of smell.

Computation Rules and Logarithms. By Prof. Silas W. Holman. Pp. xlv + 73. (New York and London: Macmillan and Co., 1896.)

THE first portion of this book treats of the way to use logarithms so as to apply no more figures than necessary; the author pointing out that probably one half of the time expended in computations is wasted through the use of excessive number of places of figures, and through the failure to employ logarithms. With this in view, rules are given showing what place tables to employ, and also how many figures to retain to obtain an accuracy of any desired percentage.

That such rules are of high importance may be seen from the fact that the use of five place tables when four would suffice nearly doubles the labour; using six place instead of four nearly trebles it, thus wasting a hundred and two hundred per cent. respectively of the necessary amount of work, and probably a greater proportion of time.

Besides these rules and the usual explanation to the collection of mathematical tables, there is a short treatment on "Notation by Powers of Ten," which, as the author sees, is a method that if taught with elementary arithmetic, it would enormously facilitate the teaching of logarithms; but his "Symmetrical Grouping of Figures" about the unit's place is a departure likely to be received with some degree of conservatism. There is a useful paragraph on the "Habit in Reading off Numbers or Logarithms," which consists in emphasising and grouping the figures in a certain habitual way. The latter part of the book is taken up by a collection of mathematical tables, *e.g.* logarithms, antilogarithms and cologarithms to four places, logarithms to five places, logarithms of the trigonometrical functions, slide wire ratios to four places, &c. The decimal point, usually omitted, has been retained in the tables for facilitating in reading off.

Remarkable Eclipses. By W. T. Lynn. Pp. 52. (London: Edward Stanford, 1896.)

THIS "sketch of the most interesting circumstances connected with the observation of solar and lunar eclipses, both in ancient and modern time," appears at a very appropriate time, since in a little more than two months the general public will be mildly interested in a total eclipse of the sun, for the observation of which in Norway, Japan, and elsewhere, many astronomers are making preparations. Mr. Lynn has contrived to compress a marvellous amount of very readable information in his slender little volume, and as a condensed statement of the history of eclipse observations his essay is admirable. The book is uniform with "Remarkable Comets," and it deserves the same successful career as its forerunner.

The Old Light and the New. By Wm. Ackroyd, F.I.C. Pp. 102. Illustrated. (London: Chapman and Hall, Ltd., 1896.)

WE very much question the wisdom of placing this book upon the market. The information on researches with Röntgen rays is very sketchy, while a large portion of the book, dealing with theories of the natural colours of bodies, is nothing more than padding, and is altogether out of place in a volume of this character.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Curious Idiosyncrasy.

A STRONGLY marked idiosyncrasy has lately come to my notice, which should be recorded. A lady of my acquaintance was walking with a relative, Colonel M., when the wife of a tenant addressed her, and described how the hand of her own child had been pinched in a door. Overhearing her story, Colonel M. became quite unwell, so much so as to lead to particular inquiry, which resulted in showing that allusions to any accidents of that kind affected him at once in a very perceptible way. Finally, at the request of the lady, he wrote an account of his peculiarity, which she forwarded to me. Thereupon I corresponded with Colonel M., who slightly revised what he had written, and sanctioned its publication. It is as follows:—

"From my earliest remembrance, and still up to now, any sight of an injured nail in any person, even if a total stranger, or any injury, however slight, to one of my own nails, causes me to break into a deadly cold perspiration, with feeling of sick faintness. But still further; if I chance to hear any one else narrating in casual conversation any injury of this particular sort to themselves or others, it brings on me exactly the same feeling I have described above. So much is this the case, that many years ago, when I was in the prime of life, at a large dinner party, when one of the guests near me persistently chanced to go on talking minutely of some such little accidental injury that had befallen him, I turned very faint, tried all I knew to shake it off, but could not, and presently slid right under the table quite unconscious for the moment. This is the more singular because on no other point am I in the least squeamish. In old days I have seen soldiers flogged before breakfast without its affecting me, though some of the rank and file would be very much upset, and in cases of death, illness, or wounds, I have never experienced, as an onlooker, the sensations I have alluded to above."

I may mention that the mother of Colonel M. had pinched her own finger-nail badly shortly before his birth, and, as is not uncommon in coincidences of that kind, she believed her accident to have been the cause of her son's peculiarity. He writes to me:—

"As a boy I was conscious of this repugnance of mine, but was ashamed of it, and never used to mention it to any one. When I became a young man I one day mentioned it *privately* to my mother, who it appeared had already noticed it in me as a child. She then told me the incident about her own finger, and she and I being both utterly unscientific persons, assumed then and there that my squeamish feelings about injuries to finger-tips must be connected with her little accident."

In reply to further questions, I learn that the injury to the mother, however painful at the time, was not so severe as to leave a permanent mark. Also, that no analogous peculiarity is known to exist among the near relations of Colonel M., of whom he specifies his father, brother, three sisters, nephews and nieces. He has no children.

This anecdote proves, so far as the evidence goes, that a very peculiar idiosyncrasy may spring suddenly into full existence, and need not develop gradually through small ancestral variations in the same direction. It is a more astonishing phenomenon than the equally sudden appearance of musical faculty in a single member of a non-musical family, being very special, and so uncommon and worse than useless that its ascription to reversion, in the common sense of the word, would be absurd. That is to say, it would be silly to suppose a sickly horror of wounded finger-nails or claws to have been so advantageous to ancient man or to his brute progenitors, as to have formerly become a racial characteristic through natural selection, and though it fell into disuse under changed conditions and apparently disappeared, it was not utterly lost, the present case showing a sudden reversion to ancestral traits. Such an argument would be nonsense. But though this particular characteristic is of negative utility, its existence is a fresh evidence of the enormously wide range of possibilities in the further evolution of human faculty.

FRANCIS GALTON.

Becquerel's and Lippmann's Colour Photographs.

The point raised by Prof. Meldola (p. 28) is partially, if not completely, answered by Otto Wiener in a most valuable paper, "Ueber Farbenphotographie durch Körperfarben, und Mechanische Farbenanpassung in der Natur," published in *Wiedemann's Annalen*, 1895, lv. 225–281. Wiener devised a method of examining colour photographs through a right-angled prism in such a way that pigment colours, which owe their hues to absorption, are distinguished from interference colours by not changing their positions when seen through the prism. The application of this method to colour photographs by Lippmann's process and the older processes of Seebeck, Poitevin and Becquerel, shows that in Lippmann's photographs the colours are due entirely to interference. In Becquerel's process they are due mainly to interference, though pigment colours are formed to an extent which is generally very small, but which increases with the duration of the exposure. The colours on Becquerel plates *do* change with the angle of incidence, though the changes are very small, probably in consequence of the high refractive power of the film. Further, when the film is examined from the back the colours do not occupy the same positions as when they are viewed from the front. It follows that the colours on Becquerel plates are due essentially to the same cause as those on Lippmann's plates, and the theory of standing waves is applicable in both cases.

With the processes of Seebeck and of Poitevin, on the other hand, the colours are exclusively pigment colours, and the theory of standing waves is not applicable.

Weston-super-Mare, May 16. C. H. Bothamley.

Influence of Terrestrial Disturbances on the Growth of Trees.

In reply to the note of Mr. H. J. Colbourn on "Influences of Terrestrial Disturbances on the Growth of Trees," in your issue of April 23, allow me to say that his ingenious suggestion of connecting a zone of narrow rings in a section of Douglas spruce with some supposed terrestrial disturbances occurring about the same time, is hardly tenable, even if the coincidence of the two phenomena were established, which seems not to be the case. The occurrence of a zone of narrow rings is common in all our trees, and I have observed it most frequently in all southern pitch pines, which are rarely over three hundred years old, and hence outside of the possibilities of the influence of unknown or uncertain terrestrial disturbances.

The suddenness with which the rings become narrow and then again wide, described by Mr. Colbourn, and observed by us in many other trees, is, to be sure, puzzling; nevertheless, we cannot escape the conclusion that it is due to changes in the conditions surrounding the tree. Yet it is not necessary that the change of conditions and of ring-width should be simultaneous, that is to say, the change of conditions may have occurred without having been immediately responded to by the growth of the tree.

The following explanation may serve as a type. Let a tree grow up under favourable conditions for a hundred years, as the Douglas spruce in question seems to have done, when its ring-growth will be wide, its crown reaching above its neighbours. A hurricane breaks off a large part of its crown, when necessarily and suddenly, at least within a year, the rings become narrow in proportion. Within the next thirty years the crown recuperates, which in a resinous conifer like the Douglas spruce is possible without fear of fungus attacks and decay; but the food-material descending from the foliage will for a long time be only sufficient, on the particular section in question at the base of the tree, to make the narrow annual ring, even after the crown is fully recuperated. Were a section cut higher up in the tree, it would be found that the rings there have begun to widen sooner than at the lower section. Finally, and rather suddenly for any given section, the supply has become normal, and especially if an exceedingly favourable season occurs at the same time the rings show again normal width.

The same sudden change from narrow to wide rings is observed when a tree oppressed by its neighbours is suddenly relieved by windfall or by man's interference from its oppressors; but the response even then is not simultaneous, it takes one or more years before the crown is in condition to utilise the full amount of light at its disposal, and to furnish food to all parts of the tree in increased ratio. B. E. Fernow.

Washington, D.C., May 11.

Our Bishops and Science.

The friends of both science and religion will thank you warmly for publishing the Bishop of Ripon's public testimony to Huxley's spirit of sincerity and love of truth. It is the more timely because of your recent strictures upon the Bishop of London. May I therefore, as a country parson, with an equal love for scientific integrity and religious truth, suggest to the readers of those strictures in Nature (p. 607, April 30) that probably Bishop Temple has been misunderstood. I am sure it is not fair to his spirit to put into his mouth, "Away with all these abominations. Purge the elementary schools of everything scientific, and substitute dogmas and subjects more fitted to the stations of life in which it has pleased God to call the scholars."

Is it not more likely that the real clue is in the sentence quoted about "instructing little children in *elementary* schools in *a great many scientific subjects?*" For many earnest educationalists have, as friends of science, spoken strongly on the evils of the cramming of bits of science subjects and "stages" by crudely crammed "Government certificated" "science" teachers cramming large classes for grants on "passes" to butter their bread.

In any case, the true views of the great bishop will be found in his "Bampton Lectures" for 1884, on the relations between science and religion; and the last *Quarterly Review*, on G. J. Romanes, contains an eminent example of the reverent treatment of both.

I will frankly add that I do not think your quotations from Mr. Mundella's address can be too widely known among the bishops and clergy who have such influence with the laity. Agricultural pursuits suffer more from our ignorance than our want of money; and agricultural science cannot be widely taught until the elementary principles of chemistry and physics are diffused in our villages.

On this subject we have also had the weighty testimony of Mr. Gladstone. The voting of money for light railways and such objects is a quack remedy. The fact is that true educational enthusiasts who will think first of our children, and be generous to them *first*, have hitherto been appallingly scarce in the House of Commons and its parties.

Nor is even the *geographical* significance of our need of science education likely to be perceived by the majority, if, as is stated in the *Anti-Slavery Reporter* (March–April 1896, p. 80), two M.P.s can stand before a map of South America in the map room of the House of Commons, and dispute with one another as to where Egypt was to be found on that map. However matters are mending, we hope. J. F. Heyes.

Crowell, Oxon, May 15.

Blood-Brotherhood.

There are good reasons why this ancient custom can never be a preventive of disease, though sometimes it may be a cause of it. The serum treatment has been found useful, and presumably will be found useful only in such diseases or diseased conditions as are due to poisons (toxins) secreted by various species of pathogenic micro-organisms (*e.g.* those of rabies, anthrax, diphtheria), or by some animals (*e.g.* scorpion, snake), as weapons of offence or defence.

As regards certain zymotic diseases (*e.g.* small-pox, scarlatina, syphilis), it is known that one attack confers more or less complete immunity against subsequent attacks; that is, the micro-organisms of these diseases are, after the recovery of the host, unable to persist and produce their toxins in him; and this for the reason that during his illness certain of his body cells, known as phagocytes, become inured to the toxins, and are thus enabled to attack and destroy the micro-organisms producing them. When the phagocytes fail to become inured, the micro-organisms continue to produce these toxins, and the host perishes, poisoned by them. Now the toxins produced by the micro-organisms of most zymotic diseases are not always of the same degree of virulence, and when they are feeble the phagocytes the more easily become inured to them, and destroy the micro-organisms; and not only do they do so, but this preliminary training enables them, when attacked by more virulent micro-organisms of the same species, *i.e.* of the same disease, to react to the stronger toxins of these also, and again destroy the micro-organisms. Man has taken advantage of this fact to artificially lower or "attenuate" the virulence of various species of pathogenic micro-organisms (*e.g.* those of anthrax an

cholera); and inoculation with them or their toxins inures the individual so treated to resist the attacks of micro-organisms of the same species and of the normal degree of virulence. One way of attenuating or rendering less virulent the toxins is to inject them into an animal that does not easily perish of them (*e.g.* horse, as regards diphtheria), when they undergo partial intracellular digestion within his tissues. His blood serum then contains altered toxins (the so-called anti-toxins), experience of which inures the cells of an animal of a more susceptible species (*e.g.* man) to resist the attack of virulent micro-organisms with unaltered toxins. It is noteworthy that when toxins and anti-toxins are mixed the latter may inure the cells to the former before death occurs, for the reason that these do not under normal conditions cause immediate death. For this reason animals are able to withstand much more than a fatal dose of a toxin when it is mixed with the appropriate anti-toxin, and sometimes even to recover from a disease which would otherwise be fatal if during the course of it the anti-toxin is injected. But toxins and anti-toxins are not retained within the system. They are digested by the cells and excreted, and therefore enduring immunity is not conferred by their presence, but by the fact (in some diseases at least) that when the cells are once inured they remain so.

It is clear that the serum treatment can be useful only in diseases against which immunity may be acquired, if only for a short time. In other diseases (*e.g.* tuberculosis, malaria, leprosy) against which immunity cannot be acquired, which do not run a pretty definite course of limited duration, of which one attack does not protect against subsequent attacks, it is useless; for here training does not benefit the cells, or if in some cases it does benefit them, this benefit is of such limited duration as to be practically useless.

After this, from want of space, very dogmatic statement of the rationale of serum-therapeutics, let us inquire what may be hoped from the ceremony of blood-brotherhood in its medical aspects. Clearly nothing. It will not, of course, endow the traveller with his blood-brother's powers of resisting hardship (heat, cold, hunger, &c.); it will not confer immunity or increased powers of resistance against that class (the most death-dealing class) of diseases against which immunity *cannot* be acquired; and lastly, it will not confer immunity or increased powers of resistance against that class of diseases against which immunity *can* be acquired, unless there is present in the blood-brother this or that micro-organism in an attenuated form, or unless antitoxins are present in him to an inconceivable degree of concentration—very remote possibilities, or rather impossibilities, on which the traveller were wise not to count. On the other hand the blood-brother may communicate actual virulent disease, for instance syphilis and malaria.

G. ARCHDALL REID.

Remarkable Sounds.

IN a Japanese work, "Hokuetsu Kidan," by Tachibana no Mochiyo (published *circa* 1800, tom. ii., fol. 5, *seqq.*), I have found some remarkable sounds described. Among the details given therein of the "Seven Marvels of the Province of Echigo," we read: "The fifth marvel, the Dônari [literally *Body Sounds*, or *Temple Sounds*], is a noise certain to be heard in the autumnal days, just before a fine weather turns to stormy, it being sounded as if the thunder falls from the cloud, or the snow slides down a mountain. Where it originates is quite uncertain, as there are in the counties several mountains assigned therefor. The sounds are heard of same intensity in variously distant places." Further, the author recites a folk-tale current in his time among the villagers of Kurotori, in Co. Kambara, which attributes these sounds to the head and body of a hero, Kurotori Hyôe [killed in 1062?]; separately interred under a Shintoist temple in this village, they ever strive to unite once more. "The marvel, it is said, is now seldom met with; still it occurs frequently within two or three miles of the village, proceeding doubtless from the precinct of the temple. And the fact is more wonderful that the inhabitants of Kurotori themselves never hear the sounds unless they go out of the village." Concluding the narrative, the author, from his personal observation, argues the action of the tide-waves upon the earth to be the real cause of these curious sounds.

May 18. KUMAGUSU MINAKATA.

BOSNIA-HERZEGOVINA AND DALMATIA.

THE progress of prehistoric archæology, the youngest of the inductive sciences, is one of the more important facts in the history of the intellectual development of the latter half of the nineteenth century. Up to 1870, attention was chiefly directed to the antiquity of man and his place in the geological record, and to the classification of his advance in the Neolithic, Bronze, and Iron ages in Europe. Man was proved to have lived in a remote past, not to be measured by years and under climatal and geographical conditions totally different to those now met with in Europe. The next ten years were chiefly spent in elaborating the details as to the range of Palæolithic man, and in working out the sequence of events, separating the Pleistocene period from the dawn of history. The Neolithic, Bronze, and Prehistoric Iron ages of human progress were traced far and wide over nearly the whole of the old and the greater part of the new worlds. In the last decade the centre of archæological interest has shifted slowly in the direction of the frontier of history. On the one hand the researches of Flinders Petrie have revealed the close connection of ancient Egypt with the nations of the Mediterranean long before the rise of the Greeks, and have rendered it possible for us to use the Egyptian chronology as the standard to fix the date of prehistoric events in Southern Europe and in Asia Minor. On the other, in these latter areas, many workers, among whom Schliemann stands foremost, have revealed the manners and customs, the daily life, the modes of warfare, the habitations, fortresses and tombs of the very peoples who were in touch with Egypt. We even know, thanks to Arthur Evans, that there was a system of writing in the Ægean area long before the introduction of the Phœnician alphabet, and we may look forward to his future researches to make it intelligible.

A valuable book[1] on Bosnia-Herzegovina and Dalmatia is the last contribution to the subject. Under the modest title of "Rambles and Studies," it might very well be taken for the usual book of travels in a land of wonderful beauty, till now practically closed to the ordinary traveller. Under the Austro-Hungarian dominion, now some twenty years old, good roads have replaced the old tracks, and law and order reign instead of the brigandage of the past. New lines of railway and of steamers connect the chief centres, manufactures are encouraged, and schools for the education of both Christian and Moslem are in full swing. There are luxurious hotels in place of the old caravanserais, and the records of the past are being carefully preserved in museums, under the charge of competent scientific men, instead of being ruthlessly destroyed, as they were under the old *régime*. There are snow-covered mountains, great rivers and waterfalls, like those at Ottawa, and lakes embosomed in trees. There are ravines, like those of Miller's Dale, only larger, and caverns, and all the characteristic scenery of the limestone forms the surface of the country. The interest, however, chiefly centres in the inhabitants. The present phase of transition from Eastern to Western ideas is of special value at this time, when the cry of oppressed lands is ringing in the ears of the Western nations, because it shows with what extraordinary rapidity a people ground down to the dust for centuries by the Turk, may become happy and prosperous under a good system of local self-government. What the Austro-Hungarians have done in the Bosnia-Herzegovina, may be done by the Powers in Asia Minor and in the islands of the Ægean Sea. From this point of view Dr. Munro's well-written book is worthy of the attention of our rulers. Dr. Munro has dealt with all these things with a light and pleasant

[1] "Rambles and Studies in Bosnia-Herzegovina and Dalmatia." By Robert Munro, M.A., M.D., F.R.S.E. 8vo. (Blackwood, 1895.)

hand. He, accompanied by Mrs. Munro, travelled under great advantages. He went in 1894, at the invitation of the Austro-Hungarian Government, to attend an archæological congress, and he has made the most of his opportunities.

It is not, however, the traveller's side of the book which more immediately concerns us. It is rather with it as a contribution to archæological literature, in which the author brings to bear, on the discoveries made in those lands by others, the scientific method which he had already used so well in carrying out his investigations into Lake-dwellings in Britain and on the continent. We shall review in their chronological order the more important of the discoveries, now laid before English readers, in a quarter of Europe shut off by lofty mountain ranges from the pathways of the nations.

The group of Neolithic remains at Butmir gave rise to much difference of opinion at the congress. According to Mr. Radimsky, they were deposits of refuse round ancient huts on the land, and the irregular amœba-like hollows in the clay were taken to be the bases of huts. In Dr. Munro's opinion these hollows were made by the extraction of the clay for the covering of the wattles of the huts, as well as for the large amount of pottery and terra-cotta found on the site. He points out that they have been filled up by the deposit of silt under water, as well as by human débris, and concludes that the whole accumulation was formed in and round pile-dwellings like those of Switzerland, the piles of which, as well as all the other woodwork, have wholly rotted away. We agree with this view; and would advance a further argument in its favour, that a settlement on a clay soil liable to floods is unknown in the history of Neolithic dwellings. On that spot pile-dwellings would be the only habitations possible. The inhabitants were skilful potters, and their vessels made by hand were in some cases ornamented by spirals. They also manufactured stone implements, polished axes, spears, arrows, and the like. They were also spinners and weavers; they had herds of pigs, domestic oxen, among which we may note the short-horned ox (*Bos longifrons*), and flocks of sheep and goats. In their fields they grew wheat and barley, and carried on a trade by barter with other communities. The rude terra-cotta idols imply that they had some kind of religion. Their burial-places have not yet been discovered. Among the purely Neolithic remains are twenty-seven perforated axe-hammers of a type found in the Bronze age elsewhere, and made of a stone which does not exist in the district. With the exception of three, all the rest of the implements amounting to 5118, are of native stone. It is probable that in this out-of-the-way place the Neolithic civilisation lingered long after the Bronze age had begun in the more accessible surrounding districts. We may accept Dr. Munro's conclusion, that the settlement of Butmir "is one of the side eddies of the early stream of immigrants who found their way into Europe by the Danubian valley from the regions to the south and east of the Black Sea," in the Neolithic age, and who lived on into the Bronze age—an age which in Bosnia is not so well defined and conspicuous as it is in Germany, Scandinavia, and Western Europe generally.

While bronze implements and weapons were gradually finding their way into Bosnia-Herzegovina, a new civilisation appeared at the head of the Adriatic, and extended over the southern watershed of the Danube, Northern Italy, the Tyrol and the adjacent regions, known, from the principal site of the discoveries, as that of Hallstadt. From this centre the characteristic products were scattered far and wide over Europe by means of commerce, marking the close of the Bronze and the beginning of the Iron age. The tumuli on the plateau of Glasinac, more than 20,000 in number, mark this age in Bosnia. Of these about one thousand have been explored, proving that both inhumation and cremation were practised. The articles buried with the dead consist of iron knives swords, spear-heads and axes, some double-edged, others in the shape of socketed celts. Bronze vessels, pendants, bracelets, finger-rings, and brooches, were discovered in great variety. The brooches are of great interest as indices to the age of the tumuli. This is marked by the stage presented in the evolution of the brooch from a straight pin. The first stage is presented by the bending of the pin; the second, by its being twisted round so that the point is brought to rest on a development of the head specially made to receive it; the third, by the development of one or more twists, so as to form an elastic spring or springs—the safety-pin type. From those of one spring, the Greek and Roman fibulæ are descended. At Glasinac about 44 per cent. were those with two springs, or of the Hallstadt type. Those with one are more closely allied to the Greek, while others are purely Roman. A helmet from a tumulus at Arareva is of pure Greek type and similar to one found at Olympia, bearing an inscription that it was dedicated by the Argives to Zeus out of the spoils of Corinth. It is also identical with the helmet on a warrior carved on the Harpy Tomb, Xanthos, Lycia, in the British Museum. Both these belong to about the middle of the sixth century before Christ. These things were found along with an infinite variety of ornaments and implements of bronze, iron and silver, of glass and amber and bone, together with fragments of pottery. It is obvious that these tumuli were used from the remote Hallstadt time down to the days of the Roman dominion. It is not a little remarkable that there is no mention of coins in the three elaborate volumes recording these discoveries, published by the scientific staff of the Public Museum in Sarajevo. Coins had not then found their way into the country, or if they had, were not buried with the dead.

In 1890 a cemetery was discovered at Jezerine, belonging to the same period as the tumuli of Glasinac, and containing the same types, but with fewer weapons. It is remarkable for the beautiful rings and beads made of blue, yellow, white and green glass. A gravestone with a figure of a warrior found here is assigned by Dr. Hoernes to the late Hallstadt period. The helmet with the lofty crest reaching far down the back is identical with that carved on the Harpy Tomb at Xanthos, and those on the heads of warriors, on painted early Greek vases. It may very well be of late Hallstadt age, as well as early Greek.

Besides burial-places such as the above, there are numerous forts belonging to this people, similar in construction to the hill-forts of Scotland, and built of rubble masonry without mortar.

Nor are we without evidence as to the physique of the people themselves. Of thirty-two human skulls from Glasinac, examined by Dr. Glück, 76 per cent. are either long or mesocephalic, while 24 per cent. are short; a fact of considerable interest when contrasted with the present roundness of head of the Bosnians. Out of 1500 natives examined by Dr. Weissbach, 7 per cent. only were long and 93 per cent. short.

The prehistoric inhabitants of Bosnia, like those of Hallstadt, were mainly long-headed, while the presence of the short-headed minority shows the existence of two races in both regions. The reversal of this in Bosnia in later times is due to the immigration of short-headed people, mostly Slavs, from the time of the tumuli down to the present day. It may be inferred that in Herzegovina and Bosnia, as in Western Europe, the aboriginal and Neolithic peoples were long-headed, and that they were invaded by a new race of round-headed conquerors. Whether this took place in the Bronze age must be left for future inquiry, and whether it took place from the line of the valley of the Danube, or, as Dr. Munro suggests, by the head of the Adriatic, must also be left an

open question in the present condition of the inquiry. The close connection with Hallstadt renders the latter view the more probable, although there is clear proof of the Greek influence from the south. This, however, it must be admitted, may belong to a later period.

In closing this review, we may congratulate Dr. Munro on his success in writing a book which is short, picturesque, and scientific; and we feel sure that he will gain his end, of attracting attention to the archæological treasures awaiting the explorer in this hitherto little-explored corner of Europe. W. Boyd Dawkins.

EXPERIMENTS IN MECHANICAL FLIGHT.

I HAVE been for some years engaged in investigations connected with aerodromic problems, and particularly with the theoretical conditions of mechanical flight. A portion of these have been published by me under the titles "Experiments in Aerodynamics" and "The Internal Work of the Wind," but I have not hitherto at any time described any actual trials in artificial flight.

With regard to the latter, I have desired to experiment until I reached a solution of the mechanical difficulties of the problem, which consist, it must be understood, not only in sustaining a heavy body in the air by mechanical means (although this difficulty is alone great), but also in the automatic direction of it in a horizontal and rectilinear course. These difficulties have so delayed the work, that in view of the demands upon my time, which render it uncertain how far I can personally conduct these experiments to the complete conclusion I seek, I have been led to authorise some account of the degree of success which has actually been attained, more particularly at the kind request of my friend Mr. Alexander Graham Bell, who has shown me a letter which he will communicate to you. In acceding to his wish, and while I do not at present desire to enter into details, let me add that the aerodrome, or "flying-machine" in question, is built chiefly of steel, and that it is not supported by any gas, or by any means but by its steam-engine. This is of between one and two horse-power, and it weighs, including fire-grate, boilers, and every moving part, less than seven pounds. This engine is employed in turning aerial propellers which move the aerodrome forward, so that it is sustained by the reaction of the air under its supporting surfaces.

I should, in further explanation of what Mr. Bell has said, add that owing to the small scale of construction, no means have been provided for condensing the steam after it has passed through the engine, and that owing to the consequent waste of water, the aerodrome has no means of sustaining itself in the air for more than a very short time—a difficulty which does not present itself in a larger construction where the water can be condensed and used over again. The flights described, therefore, were necessarily brief. S. P. Langley.

Through the courtesy of Mr. S. P. Langley, Secretary of the Smithsonian Institution, I have had on various occasions the privilege of witnessing his experiments with aerodromes, and especially the remarkable success attained by him in experiments made on the Potomac River on Wednesday, May 6, which led me to urge him to make public some of these results.

I had the pleasure of witnessing the successful flight of some of these aerodromes more than a year ago, but Prof. Langley's reluctance to make the results public at that time prevented me from asking him, as I have done since, to let me give an account of what I saw.

On the date named, two ascensions were made by the aerodrome, or so-called "flying machine," which I will not describe here further than to say that it appeared to me to be built almost entirely of metal, and driven by a steam-engine which I have understood was carrying fuel and a water supply for a very brief period, and which was of extraordinary lightness.

The absolute weight of the aerodrome, including that of the engine and all appurtenances, was, as I was told, about 25 pounds, and the distance, from tip to tip, of the supporting surfaces was, as I observed, about 12 or 14 feet.

The method of propulsion was by aerial screw propellers, and there was no gas or other aid for lifting it in the air except its own internal energy.

On the occasion referred to, the aerodrome, at a given signal, started from a platform about 20 feet above the water, and rose at first directly in the face of the wind, moving at all times with remarkable steadiness, and subsequently swinging around in large curves of, perhaps, a hundred yards in diameter, and continually ascending until its steam was exhausted, when, at a lapse of about a minute and a half, and at a height which I judged to be between 80 and 100 feet in the air, the wheels ceased turning, and the machine, deprived of the aid of its propellers, to my surprise did not fall, but settled down so softly and gently that it touched the water without the least shock, and was in fact immediately ready for another trial.

In the second trial, which followed directly, it repeated in nearly every respect the actions of the first, except that the direction of its course was different. It ascended again in the face of the wind, afterwards moving steadily and continually in large curves accompanied with a rising motion and a lateral advance. Its motion was, in fact, so steady that I think a glass of water on its surface would have remained unspilled. When the steam gave out again, it repeated for a second time the experience of the first trial when the steam had ceased, and settled gently and easily down. What height it reached at this trial I cannot say, as I was not so favourably placed as in the first; but I had occasion to notice that this time its course took it over a wooded promontory, and I was relieved of some apprehension in seeing that it was already so high as to pass the tree-tops by twenty or thirty feet. It reached the water one minute and thirty-one seconds from the time it started, at a measured distance of over 900 feet from the point at which it rose.

This, however, was by no means the length of its flight. I estimated from the diameter of the curve described, from the number of turns of the propellers as given by the automatic counter, after due allowance for slip, and from other measures, that the actual length of flight on each occasion was slightly over 3000 feet. It is at least safe to say that each exceeded half an English mile.

From the time and distance it will be noticed that the velocity was between twenty and twenty-five miles an hour, in a course which was constantly taking it "up hill." I may add that on a previous occasion I have seen a far higher velocity attained by the same aerodrome when its course was horizontal.

I have no desire to enter into detail further than I have done, but I cannot but add that it seems to me that no one who was present on this interesting occasion could have failed to recognise that the practicability of mechanical flight had been demonstrated.

Alexander Graham Bell.

THE APPROACHING CELEBRATION OF THE KELVIN JUBILEE IN GLASGOW.

IT may interest our readers to state the programme of the approaching celebration of the jubilee of Lord Kelvin as Professor of Natural Philosophy in the University of Glasgow.

On the evening of Monday, June 15, at 8.30 p.m., the University will give a conversazione, when there will be an

exhibit of Lord Kelvin's inventions. On Tuesday, June 16, addresses will be presented to Lord Kelvin by delegates from home and foreign University bodies, from several of the learned Societies of which he is a member, from student delegates from other Universities, and from the students and graduates of the University of Glasgow. It is expected that the honorary degree of LL.D. will be conferred on the same day on several of the distinguished foreign visitors. On Tuesday evening, June 16, the City will give a banquet to Lord Kelvin, to which the visitors who have come to do him honour have been invited.

On Wednesday, June 17, the Senate of the University will invite the visitors of the University staff to sail down the Clyde. The students of the University also invite the students' delegates from other Universities to a similar trip.

Representative scientific men—about fifty in number—from America and the British colonies, and from all the European countries, and about 150 from the United Kingdom, have signified their intention to be present.

The exceptional nature of the occasion, and the feeling which Lord Kelvin's name awakens everywhere, will give these proceedings a peculiar interest.

NOTES.

THE University of Wales is to be represented at the forthcoming celebration of the Kelvin jubilee by Principal J. Viriamu Jones, F.R.S., of Cardiff (the Vice-Chancellor for the year), and Prof. A. Gray, of Bangor.

THE Mayor of Bristol, at the suggestion of a deputation representing the chief local scientific societies and educational institutions, has decided to invite the British Association to visit Bristol in 1898. A visit to Bristol after the Toronto meeting would be made in a singularly opportune year, for it was in 1497 that Cabot discovered the American mainland, where the Association will be in 1897, whence he started on his second voyage in 1498. The meeting would thus serve to commemorate the tercentenary of a memorable voyage of one of Bristol's greatest citizens. That the Association should take Bristol after Canada would, therefore, be very appropriate.

THE Epidemiological Society of London has resolved, having regard to the historical connection of the Society with vaccination and other preventive measures, to found a medal in memory of Jenner. It is proposed that the medal shall be founded with a view to the promotion of epidemiological research, and that it shall be bestowed from time to time by this Society on persons who shall have contributed to the knowledge of preventive medicine. Donations (not exceeding one guinea) may be sent to the Honorary Treasurer, 6 Hereford Mansions, Bayswater, W.

THE death is announced of Dr. August Hosius, Professor of Mineralogy and Palæontology in Münster University.

THE King of Belgium has honoured Prof. Leo Errera, Professor of Botany in the Université Libre de Bruxelles, and Director of the Institut botanique, by creating him a Chevalier of the Order of Léopold.

REUTER'S correspondent at Adelaide states that a well-equipped expedition started on May 22 to explore the interior of the Australian continent. It will be absent eighteen months. Mr. Calvert is defraying the cost of the expedition.

AN extra Friday evening meeting of the members of the Royal Institution will be held on June 19, when Mr. Thomas C. Martin, of New York, American Delegate to the Kelvin jubilee, will deliver a lecture on "The Utilisation of Niagara."

WE learn from the *American Naturalist* that a biological station will be opened on June 22 at Biscayne Bay, Florida, and will remain open for six weeks. The place is well situated for the study of the tropical and subtropical flora and fauna, while its situation upon the continent makes it more readily accessible than the West India Islands. The station will be under the direction of Prof. Charles L. Edwards, of the University of Cincinnati.

MR. T. D. A. COCKERELL proposes to establish a biological station at Las Cruces, New Mexico, U.S.A. The climate of the country is exceptionally favourable for persons in the earlier stages of phthisis, while the abundance of new and interesting forms of life, especially among the insects, is remarkable. Many interesting general problems, such as those of the life-zones, can also be studied in New Mexico to great advantage. A beginning will be made this summer if students can be found. Mr. Cockerell will be glad to hear from any who are interested in the matter, and especially from those who might be inclined to work with him for longer or shorter periods during the present summer.

A GENERAL meeting of the members of the Federated Institution of Mining Engineers will be held in London on Thursday, June 4, and on Friday, June 5. The following papers will be read, or taken as read:—Presidential address, by Mr. Geo. A. Mitchell; "The Causes of Death in Colliery Explosions," by Dr. J. S. Haldane; "Road Engines," by Mr. John McLaren; "The Gobert Freezing Process of Shaft-sinking," by Mr. A. Gobert; "Precautions necessary in the Use of Electricity in Coal-mines," by Mr. H. W. Ravenshaw. The papers down for discussion are: "Photography in the Technology of Explosives," by Mr. Alfred Siersch; "Coal-washing Plant at the Wirral Colliery, Neston, Cheshire," by Mr. J. Platt; "Lead and Lap of Winding and other Engines," by Mr. Hargrave Walters.

THE gold medal of the Linnean Society of London, which is annually presented alternately to a zoologist and to a botanist, has this year been awarded to Prof. George James Allman, F.R.S., for distinguished researches in zoology. A graduate in medicine in the University of Dublin in 1844, and subsequently Regius Professor of Botany there, he was elected a Fellow of the Royal Society in 1854, and from 1855 to 1870 held the chair of Regius Professor of Natural History in the University of Edinburgh, where the honorary degree of LL.D. was conferred upon him. In 1873 he was awarded the "Royal Medal" of the Royal Society. In 1874 he was elected President of the Linnean Society in succession to Mr. Bentham, and in 1879 was President of the British Association on the occasion of its meeting at Sheffield. His chief scientific work has relation to the lower forms of animal life, concerning which his most notable publications are his monographs of the Freshwater Polyzoa and Hydroida—issued by the Ray Society—and his exhaustive report on the Hydroida collected by the *Challenger* exploring expedition. The medal will be presented at the anniversary meeting of the Linnean Society, to be held on Thursday, June 4, at 8 p.m.

MESSRS. C. GRIFFIN AND CO. have just published the thirteenth annual issue of their "Year-Book of Scientific and Learned Societies of Great Britain and Ireland." The work comprises lists of papers read during 1895 before these societies, which are arranged into fourteen classes according to the branches of science fostered by them. As a handy and accurate index to our scientific societies, and a record of progress, the work is most useful.

WE learn from *La Nature* of May 23 that a meeting was held on April 24, at the Geological and Geographical Society of Stockholm, in favour of the Polar expedition of M. Andrée. That gentleman opened the meeting by an explanation of the preparations already made, and of the prospects of the expedition. The generator of the hydrogen gas is nearly

completed, and the steamer *La Vierge* is in dock at Gothenburg. A folding canvas boat, to carry three persons and 600 kilograms of provisions, has also been constructed. The expedition is to sail from Gothenburg on June 7, and should arrive at Spitzbergen about the 18th of that month. After that, M. Andrée cannot state what may happen—whether it will be a long balloon voyage, or a sledge and boat journey. M. Ekholm enumerated the various instruments which will be taken; they include several self-recording meteorological instruments, photographic apparatus, and electrometer. M. Strindberg gave details respecting the construction of the balloon. After the meeting a banquet took place, at which Baron Nordenskiold wished success to the expedition, to which M. Andrée warmly responded.

In spite of the numerous excursions that have been previously made to Spitzbergen, it is remarkable that so very little has been done in the interior. The botany of its coast-lands is as well known as that of many British counties; its mosses, hepatics, and marine algæ have been carefully monographed. Many groups of the fauna have been equally well described. The geology of the coast sections has been mapped, and rich collections of fossils made from the remarkably rich sequence of rocks ranging from the Devonian to the Pleistocene, and including representatives of the Carboniferous, Permian, Trias, Jurassic, Cretaceous and Miocene. Nevertheless hardly anything is known of the interior of West Spitzbergen, the largest island of the archipelago. Nordenskiöld and Palander crossed the north-east island in June 1873, but up to the present only two short excursions have been made on to the ice-sheet of the main island. The first of these was a short traverse by the late Gustav Nordenskiöld from Horn Sound to Bel Sound, and the other a visit by Ribot to Mount Milne-Edwards, to the south-east of Ice Fiord. The interior is known to be covered by an ice-sheet, and a careful study of this would no doubt throw much light on the problems of the former glaciation of Europe. An effort to fill this remarkable gap in our knowledge is now being made by Sir W. Martin Conway, who has organised an expedition to Spitzbergen, which will start on June 2. The main object of the expedition is the study of the interior, but it is hoped also to supplement our knowledge of the fauna of the coast-lands, and to make extensive collections for this country. The party will consist of five other members, Mr. Ed. Conway, Mr. R. D. Darbishire, Mr. E. J. Garwood, Dr. J. W. Gregory, and Mr. A. Trevor-Battye. The party expects to return early in September. The collections made will be the property of the British Museum, the Trustees of that institution having lent Dr. Gregory's services to the expedition.

Writing to the *Electrician* on the subject of Röntgen rays, Mr. James Mark Barr enunciates the proposition that reversing the current in a "focusing" tube improves it for its normal working after "fatiguing" has set in. He adds that the reverse current used should be comparatively weak.

A fine specimen of a rare Marine Chalonian, the Leathery Turtle (*Dermochelys coriacea*) has lately been presented to the South African Museum by Mr. P. C. Keytel, of Cape Town. The animal was stranded on Blaauwberg beach in Table Bay, and was secured by some fishermen; its length is over 5 feet, and its breadth more than 2 feet.

In the *Indian Engineer* some interesting statistics are given relating to the development of the coal fields in Labuan. The island contains four seams of coal varying in thickness from 1½ to 10 feet, and running from north-east to south-west. The coal is good steam coal containing an abundance of resin, and the outcrops are three-quarters of a mile from the sea. In prospecting for coal near the head of the Ogangara River, oil was struck, which continued to flow for a few days, when the spring became exhausted. The yearly output of coal three years ago was 18,000 tons.

The current number of the *Journal of the College of Science*, at Tōkyō, fully maintains the standard of its predecessors; but we note with deep regret the announcement of the death of Mr. Hirota, whose last paper (on the "Dendritic Appendage of the Urogenital Papilla of a Siluroid") it contains. The half-dozen monographs which have fallen from Mr. Hirota's pen are of exceptional merit, and show their author to have been a worker of much promise and sound judgment. His first paper on the "Sero-Amniotic Connection and the Fœtal Membranes in the Chick" came as a revelation; and let it be recorded to his lasting memory, that he therein disposed of an error in fundamentals, of which Western embryologists, studying the hen's egg *ad nauseum*, had never dreamt. We tender our Eastern confrères our profoundest sympathy, for their loss is our own.

A protest is raised in the *Agricultural Gazette of New South Wales* (vol. vii. part 2) against the indiscriminate destruction of beneficent lady-birds. The small yellow and black-banded pumpkin beetle, *Aulocophora hilaris*, Boisd., feeds upon many plants frequented by the 28-spotted lady-bird, *Epilachna 28-punctata*, and it is common to find these two destructive species side by side upon the same plant. This appears to have led to the misapplication of the term "lady-bird" to *Aulocophora hilaris*, with the unfortunate result that the whole of the group Coccinellidæ, to which the appellation properly belongs, has been, in the most general terms, denounced and described as a scourge. Considering that, out of the large number of species of lady-birds to be found in New South Wales, only two—*Epilachna 28-punctata* and *Epilachna guttato-pustulata*—are really injurious, it would be a great misfortune if all the useful species of Coccinellidæ were to be ostracised on their account.

The last number of the American journal, *Modern Medicine and Bacteriological Review*, draws attention to a report recently drawn up by Prof. Conn, of the Western University, on the bacteriology of milk, published by the United States Department of Agriculture. Examinations of milk made at various places yielded numbers varying from 330,000 to 9,000,000 microbes per ounce. The milk-supply of Boston was found to be particularly rich in microbes, as many as 135 million germs being found per ounce. The *Boston Medical and Surgical Journal* lately reported a case in which a young man contracted tubercular disease by drinking milk from a herd of cows, fifty-nine of which were afterwards found to be tuberculous, whilst two persons employed in making butter from the same herd, and who drank large quantities of milk, also became infected. Although much has been accomplished in our country of late years to improve the sanitary conditions surrounding our public milk-supplies, yet a great deal still remains to be done, and there cannot be a doubt that the next important step will be the distribution by our dairies of "pasteurised" milk and butter. The example has already been set by one important London dairy company, and it is to be hoped that others will follow what is, after all, but a tardy imitation of what has been done for some time past by our more enlightened neighbours on the continent.

In commemoration of the Jenner centenary, a special number of the *British Medical Journal* has been issued, containing a number of interesting papers on Edward Jenner's life, work, and writings.

The Clarendon Press announces for early publication a "Flora of Berkshire," by Mr. G. C. Druce. It is intended to be not only a catalogue, but also a history, of the plants of the county.

DR. PH. MOLLE has reprinted from the *Memoirs* of the Royal Academy of Belgium his "Recherches de microchimie comparée sur la localisation des alcaloïdes dans les Solanacées." These alkaloids are found chiefly in the superficial organs of the plant, especially in the bark, where they serve to protect it against the attacks of herbivorous animals. They are entirely absent from both the embryo and the endosperm of the ripe seeds, and can in no sense be regarded as reserve food-materials; if they occur at all in the seed, it is only in its integument.

MR. C. F. CLARKE, of Plumstead, writes to point out a clerical slip in the notice of Dr. Orchard's "Astronomy in Milton's Paradise Lost," by which Satan's shield is said to be compared to Galileo's glass (not a very large object, that of the Lick or Yerkes telescope might have been more appropriate had such then existed), instead of the moon as viewed through it. Besides the three constellations mentioned in our notice, Milton also alludes to Orion, supposed by him, as by the ancient poets, to be associated with windy and stormy weather.

WE welcome No. 12 of the *Alembic Club Reprints*, published by Messrs. W. F. Clay, Edinburgh. The volume contains Faraday's papers on "The Liquefaction of Gases" (1823-1845), and an appendix consisting of papers by Thomas Northmore on the compression of gases, which were referred to by Faraday, in his historical statement, in the following terms. "The most remarkable and direct experiments I have yet met with in the course of my search after such as were connected with the condensation of gases into liquids, are a series made by Mr. Northmore in the years 1805-6." Students of physics, and every one interested in the subject of the liquefaction of gas, should possess a copy of this latest addition to the *Alembic Club Reprints*.

THE Deutsche Seewarte has recently issued tbe last of its series of atlases dealing with maritime meteorology and other useful information relating to the great oceans. The present work, which refers to the Pacific Ocean, contains thirty-one folio coloured charts, with explanatory text, and, like its predecessors, forms an appendix to the Sailing Directions which are published in a separate form. The atlases for the Atlantic and Indian Oceans have been in the hands of German sailors for some years, and, being in a clear and popular form, are almost equally useful to other countries. In addition to the usual charts of ocean currents, specific gravity, temperature of air and sea-surface, relative frequency of winds, distribution of rainfall, &c., there are others containing useful *data*, among which we may mention the mean sailing routes, and the distribution and principal haunts of various kinds of whales. The charts are based on a large amount of information supplied by German captains, and include materials collected by other nations. A just appreciation of this part of the work of the Deutsche Seewarte is shown by the fact that it has been found necessary to prepare a second edition of the Sailing Directions for the Atlantic Ocean, which will be published as soon as practicable.

THE *Journal* of the Asiatic Society of Bengal can scarcely be said to have a place in our chemical libraries; the current number, however, contains a paper by Dr. P. C. Rây, of the Presidency College, Calcutta, on mercurous nitrite, that is worthy of note. During a preparation of mercurous nitrate by the action of dilute nitric acid in the cold on mercury, yellow crystals were deposited which, upon examination, proved to be mercurous nitrite. The analysis proved somewhat difficult, as the substance dissociates in solution into metallic mercury and mercuric nitrite. The fact that this nitrite is stable in strongly acid solutions, is an additional proof of the views advanced by Dr. Divers as to the "nitronic" constitution of the nitrites of copper, silver, mercury, and bismuth. The stability of silver nitrite towards nitric acid has already been noticed by Acworth and Armstrong, and by Russell, and the behaviour of mercurous nitrite is closely analogous. Dr. Râv proposes, in a subsequent communication, to give the results of an attempt to prepare fatty nitro-derivatives from this compound.

THE Commissioners of the St. George's Public Library record in their second report, that good progress has been made with the arrangement of the cases and specimens comprised in the natural history collection presented to the library. The donor generously undertook the laborious task of installing, classifying, and labelling the whole of the objects, as well as the preparation of the numerous explanatory reading-cases, which will contribute so much to the proper understanding of the contents of the room. The collection may now be considered as ready for the use of students, and it affords an illustration of what can be done to connect the public libraries with natural history museums generally. Certain annual subscriptions were promised for three consecutive years towards the cost of maintaining the collection, but unfortunately in the second year (1895) the full amount has not been realised. It is stated that at least £150 is required to cover the working expenses during the four years for which the Commissioners have undertaken to house the collection, until it shall be seen whether good use is made of it by natural history students; the cost of *installation* having been defrayed partly out of the library rate and partly by the donor.

THE School of Practical Science at Toronto may be proud of an Engineering Society which can issue a volume of *Proceedings* (No. 9) such as we have just received. The papers in the volume are of more than engineering interest. Mr. McLennan has a paper on "Röntgen Radiation," detailing results obtained by him; and special attention should be called to an excellent essay on "The Pendulum," by Mr. A. M. Scott, which gained for the author the 1851 Exhibition Science Scholarship allocated by the University of Toronto. There is also an original contribution on the action of heat upon cements, and another on brickwork masonry. Even astronomy finds a place in the volume. Mr. W. L. Innes contributes a brief history of celestial science, and Mr. A. T. Laing describes an ingenious planetarium devised by him. As an instance of the value of a little astronomical knowledge, we may refer to a short paper on "Aspect and Prospect," by Mr. C. H. C. Wright, in which a diagram is given to show the azimuth of the sun at any time of the year for any place in the latitude of Toronto. The diagram, which is due to Prof. Kerr, should be of much assistance to architects in deciding upon the best aspects for windows of various rooms. Other subjects treated are lightning arresters, planimeters, standards in machine shop practice, the Chicago Canal, and a simple form of telemeter.

THE Report of the American Museum of Natural History, just issued, shows notable increase in the various collections, and large and expensive additions to the building. The expeditions to Peru, Honduras, Sumatra and Mexico, have resulted in the acquisition of a large number of interesting objects and photographs. In the department of Public Instruction, regular courses of lectures have been delivered to the teachers of the public schools, and free lectures to the people on public holidays as well as every week. The department of Mammalogy and Ornithology received in 1895 the William Dutcher Collection of New York Birds, numbering over two thousand specimens, contributed by the Linnean Society of New York. A very large number of Arctic mammals and birds have been received as the result of the expedition to Greenland. The department of Vertebrate Palæontology has been enriched by the Cope Collection of Fossil Mammals of North America, comprising nearly ten thousand specimens, representing 483 species. The acquisition of this valuable collection establishes the Museum as a

centre of study and research in palæontology. Increasing interest in the Museum has been evinced by all classes of the citizens of New York. Every course of lectures has been attended by crowded audiences, and pupils of public and private schools, as well as students of science, have derived advantage from the library as well as from the collections.

Several new editions of scientific works have reached us during the past few days. The first volume of a new edition of Prof. Fleming's systematic treatise on "The Alternate Current Transformer," dealing with the induction of electric currents, has been published by the *Electrician* Printing and Publishing Co. The great progress made during the seven years which have elapsed since the appearance of the original work, has necessitated a thorough revision of the matter, and the volume as it stands now will be appreciated by all who are concerned with alternating-current practice or investigations. Another volume having practical electricity for its subject is "Electric Lighting and Power Distribution" (Whittaker and Co.), by W. Perren Maycock. The first volume of the third edition of this work has been issued in an enlarged form, after careful revision. The second edition of the first volume of Dr. Schlich's "Manual of Forestry" has been published by Messrs. Bradbury, Agnew, and Co. The original was reviewed in Nature in December 1889 (vol. xli. p. 121), and quite recently (April 2, p. 510) was referred to in these columns. The second edition contains a new part on the State in relation to forestry, and a general review of the timber requirements of the British Empire. Messrs. Longmans, Green, and Co. have issued a second edition of "The Essentials of Chemical Physiology," by Dr. W. D. Halliburton. The chief alterations made are those rendered necessary by the advance of knowledge since 1893, when the first edition was published. The fifth edition of "Southall's Organic Materia Medica," by J. Barclay, has been published by Messrs. J. and A. Churchill. To quote the sub-title, the volume is "a handbook treating of some of the more important of the animal and vegetable drugs made use of in medicine, including the whole of those contained in the British Pharmacopœia." New editions of two volumes by the late Dr. J. E. Taylor, have been received from Messrs. W. H. Allen and Co. The books are "Nature's Byepaths," a series of recreative papers in natural history, and "The Aquarium," a popular manual on the history, construction, and principles of management of public aquaria. Dr. G. Herbert Fowler has edited the sixth edition of the late Prof. Milne Marshall's valuable work on the anatomy, histology, and dembryology of "The Frog" (David Nutt). A few additions and alterations have been made, but the work remains substantially the same practical and educational handbook that it ever was. Finally, the recent changes in the Physiography Syllabus of the Department of Science and Art have resulted in the production of a new edition (the sixth) of "Earth Knowledge" (Part II.) by W. Jerome Harrison and H. R. Wakefield. The book follows the Department's Advanced Syllabus, and appears to fulfil the purpose for which it has been designed.

The additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Sir William Call; a Blue-bearded Jay (*Cyanocorax cyanopogan*) from Para, presented by Mr. H. C. T. Beadnell; four Puff Adders (*Vipera arietans*), two Ringhals Snakes (*Sepedon hæmachates*), an Egyptian Cobra (*Naia haje*), three Cape Vipers (*Causus rhombeatus*), a Cape Bucephalus (*Bucephalus capensis*), two Infernal Snakes (*Boodon infernalis*), a Nilotic Monitor (*Varanus niloticus*) from South Africa, presented by Mr. J. E. Matcham; a Grey Ichneumon (*Herpestes griseus*) from India, deposited; two Indian Tree Ducks (*Dendrocygna javanica*) from India, purchased; a Japanese Deer (*Cervus sika*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

Temperature Errors in Meridian Observations.—M. Hamy has applied his method of interference fringes to a study of the errors caused in meridian observations by the radiations of the sources of light usually employed in observatories, as well as those due to the presence of the observer himself (*Bull. Ast.*, vol. xiii. p. 178). The researches have completely demonstrated that the unequal distribution of light sources may produce errors in the measures amounting to several seconds of arc, while the heat from the observer may affect the results to the extent of several tenths of a second. It is evident therefore that the subject is one of great importance, and the interferential method is specially adapted for its investigation. M. Hamy has arrived at his conclusions from experiments made with the Gambey meridian circle of the Paris Observatory. In the case of an ordinary gas flame at a distance of 0·83 metre from the telescope, the mean angular displacement of the optic axis with respect to the meridian amounted to 2″·1, the flame being lit for ten minutes. Other observations indicate that the deviation is sensibly in inverse proportion to the square of the distance of the flame from the optic axis. The effects of different sources of light were also compared at one metre distance, and the practical outcome is that gas flames provided with chimneys are to be studiously avoided, the variation in collimation amounting in this case to 4″·4. The errors due to the heat of the human body are greatest in the case of declination measures, owing to the greater heating of the under side of the telescope tube. It is evident that these errors will depend to some extent upon the materials of which the instrument is constructed, and M. Hamy is of opinion that the best possible material is a metal of high conductivity, such as copper, in which case inequalities of temperature would be almost impossible.

Search Ephemeris for Comet 1889 V.—The following is a continuation of Dr. Bauschinger's search ephemeris for the return of Brooks's periodic comet (1889 V) (*Ast. Nach.*, No. 3350).

	R.A. h. m. s.	Decl. ° ′	Brightness.
May 28	22 2 38	−19 44	0·44
June 1	7 17	19 29	0·48
5	11 43	19 14	0·52
9	15 54	19 1	0·56
13	19 49	18 49	0·61
17	23 26	18 39	0·66
21	26 44	18 30	0·71
25	22 29 44	−18 22	0·77

The unit of theoretical brightness is that on 1889 July 8, the date of the first accurate observation. The comet was last seen in January 1891, at the Lick Observatory, when the calculated brightness was only 0·08. During June the computed path lies in the southern part of Aquarius, so that observations can only be made in the early morning.

Constants for Nautical Almanacs.—At a convention of Directors of Nautical Almanacs, held at Paris after the recent congress of the International Photographic Chart, Dr. Gill's value of the solar parallax (8″·80), resulting from heliometer observations of minor planets, was adopted, and consequently the constant of aberration becomes 20″·47. Dr. Gill's value for the mass of the moon, leading to 6″·21 for the nutation, was also adopted, and Newcomb's value was accepted for the precession.

The Planet Mercury.—A postcard from Dr. Kreutz, Kiel, contains the information that Mr. Leo Brenner, of the Manora Observatory, saw the dark part of the planet Mercury sharp and distinct on May 18, at 23h. Manora time.

STELLAR PHOTOGRAPHY WITH SMALL TELESCOPES WITHOUT DRIVING-CLOCKS.

Stellar photography has now become such an important branch of astronomy, that anything which will encourage possessors of small telescopes to turn their energies in this direction will tend towards the advancement of the celestial sciences. It is proposed to show here that useful work may be done by amateur astronomers with their ordinary small refractors, and with none of the mechanical contrivances which are essential for such large telescopes as are used in the international photographic survey of the heavens, which are driven by elaborate and

costly machinery in order that the camera shall follow the apparent motion of the stars.

The accompanying photographs were taken with a 3½-inch refracting telescope of 29 inches focus, totally unprovided with any driving mechanism, not even a tangent screw and slow-motion rod, the guiding having been performed entirely by hand. The correct rate of angular motion was secured by constant visual observation of the image of a star, much out of focus, as seen in a 2½-inch guiding telescope, carrying an eyepiece magnifying fifty times. This was mounted side by side with the telescopic camera, and moved with it.

Fig. 1 shows the instruments mounted on a firm equatorial stand which is supported on a home-made brick pillar. The 2½-inch guiding telescope, by Cooke of York, is seen on the left, provided with its total reflection prism and eyepiece, and just above it is a small "finder." On the extreme left is a counterpoise which balances the 3½-inch photographic telescope, which is on the opposite side of the declination axis, and is mounted in a home-made wooden tube of square section, with dew-cap and diaphragms of the same material. At the lower end the dark slide is seen, and behind is a smaller camera which carries an ordinary portrait lens of 2½-inch aperture, which is used for obtaining a duplicate photograph, on a smaller scale, simultaneously with the larger one. The whole is so evenly balanced by the two

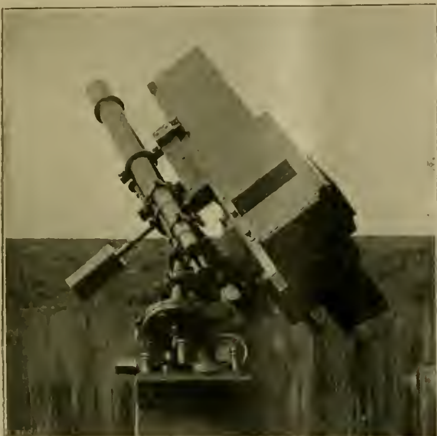


FIG. 1.—3½ inch Equatorial Photographic Telescope (as used for hand driving).

counterpoise weights—one of which is seen low down on the right—that when unclamped it remains at rest in any position. Adjusting screws are provided in order to move the telescopic camera slightly in right ascension or declination whilst the guiding telescope remains stationary. This enables one to use the nearest bright star for guiding purposes when the centre of the photographic field contains no conspicuous stars. Absolute parallelism of the two telescopes is of no importance, but their rate of angular motion must be identical. Interesting results can be obtained with such a telescopic camera without any guiding whatever. The camera remaining fixed, the images of the stars travel along on the plate and leave "trails," which appear on the negative as straight or curved parallel dark lines.

By placing a small ink dot at one end of each of these lines, the relative positions of the stars can be indicated. It was found that the faintest stars visible to the naked eye, leave trails on negatives taken with such a 3½-inch camera, and accurate charts of stars down to the sixth magnitude can be very easily secured in this manner.

These trails can also be usefully employed in certain cases to secure records of the changes of brightness of "variable" stars, as faint stars give very fine lines, and brighter stars leave thicker and denser ones on the negatives. Variations in brightness are thus recorded in the varying thickness and density of the lines, which are compared with the trails of other standard stars near. From what has been said about trails, and seeing that the image of a star moves more than its own diameter on a stationary plate in a few seconds, it is evident that all the naked-eye stars can be photographed with such an instrument with an exposure of a few seconds. As an illustration of this, a photograph taken with an exposure of only fifteen seconds, when the crescent moon was

FIG. 2.—Orion's belt. (Exposure 30 min.)

close to the Pleiades, showed not only the crescent, but also the "old moon in the new moon's arms," due to earth-shine, and twelve of the stars in the Pleiades. Accurate hand driving for such a short period is a matter of comparative ease.

Fig. 2 shows a photograph of Orion's belt taken with an exposure of thirty minutes. The negative on close examination shows stars down to the tenth magnitude. In the region represented,

FIG. 3.—The Pleiades. (Exposure 60 min.)

only about eight stars can usually be seen with the naked eye. The photograph shows that amateurs can obtain, by half an hour's exposure, a chart of any region of the sky, much more accurate and revealing a far larger number of stars than are shown in the star atlases usually in their hands. These photographs, obtained by such simple means, can always be used as records, and might easily serve for the detection of "new" and "variable" stars

when repeated at intervals and compared. The scale of these photographs is 3·4 times as large as that of Klein's Star Atlas, and the area of any region is 11·5 times larger. This is somewhat smaller than Argelander's charts.

The multiple star δ Orionis, a single star to the naked eye, is well shown as three stars, one of which is much elongated, showing the duplicity of that component; a curious S-shaped group of stars is clearly seen between δ and ε. These are quite invisible to the naked eye.

Fig. 3 represents the Pleiades as photographed with sixty minutes' exposure. In the region shown, ordinary keen eyes see only seven stars. On the negative seventy-eight stars can be counted in a space of 3° square in the centre of this region. These include stars of the eleventh magnitude.

As regards the actual driving of the telescopes, very little practice is needed; a gentle pressure of the finger at the lower end of the base-board carrying the objective and plate, is sufficient to move the telescope at the proper rate, and the co-operation of hand and eye during guiding seems soon to become almost automatic in character. When the instruments are stationary, the image of the star used for guiding, apparently travels many times faster than does the image of the star on the plate, owing to the magnification by the eyepiece; and for this reason any tendency to error in driving can be readily seen, especially with the enlarged star disc divided into four quadrants by crossed hairs in the eyepiece—long before such an error would be appreciable on the plate itself.

With the lens used, which was made by Hilger, and is uncorrected for photography, a field of good definition 5° square could readily be obtained.

An ordinary portrait lens of 2¼-inch aperture, mounted side by side with the 3½-inch refractor, gave very good results. One photograph of the Hyades, taken by its means, showed Neptune very distinctly.

The wooden dew-cap was found remarkably effective in keeping the object-glass clear, even when that of the guiding telescope, provided with a metal dew-cap, became bedewed.

When amateurs come to recognise that, with their small instruments, such a fruitful field for investigation is open to them, astronomy will probably be enriched by many discoveries which would otherwise be missed or delayed.

JOSEPH LUNT.

THE EXTINCT VERTEBRATES OF ARGENTINA.[1]

THE fossil vertebrata of South America are of peculiar interest to English palæontologists, since much of our earlier knowledge of the extinct mammals of that region is due to collections sent to this country by Sir Woodbine Parish and Darwin, and described by Owen, Clift, and others. These collections, however, valuable as they were, gave no idea of the extraordinary variety and abundance of the extinct fauna, the full importance of which has only been recognised of late years.

The terrestrial Mammalia of South America are, perhaps, the most remarkable and most strictly autochthonous in the world. If we except some marsupials as possibly Australian types and some comparatively recent immigrants, the whole of the mammals are peculiar. The American Edentata form a distinct order (for there is no reason for associating the Old World Manidæ and Orycteropidæ with them), and until the Upper Miocene (Loup Fork), they are entirely confined to the southern half of the continent. The other great divisions of the Mammalia are either represented by peculiar sub-orders or families, or, as in the case of the Insectivora, are entirely absent. Remains of this remarkable fauna are found in deposits of several horizons, which, in the wealth of species and individuals they contain, can only be compared to the Tertiary lake-basins of North America. In some cases the series seems to be sufficiently complete for the history of certain of the groups to be, at least partly, worked out, and it is to be hoped that the study of the development of these isolated types, taken in conjunction with the already clearly determined phylogenetic history of many North American groups, may lead to important generalisations as to the laws in accordance with which mammalian evolution has advanced. Unfortunately, up to the present, much less attention has been paid to points of morphological interest than to the making of new genera and species, many of which are founded on quite insufficient evidence, the result being that the nomenclature has been brought into an almost unparalleled state of confusion. It was with the intention of clearing up some of this confusion that, at the invitation of Dr. Moreno, Mr. Lydekker, in 1893–94, paid two visits to the La Plata Museum. The brief time at his disposal rendered it impossible for him to carry out his object with complete success, but he has nevertheless produced a work of the highest value, both from the purely original matter it contains, and also because it renders easily accessible descriptions and good figures of many little-known forms. Moreover, he has earned the gratitude of all students of mammalian palæontology by relegating to the synonymy a large number of imperfectly defined genera and species.

The first of the two volumes contains three memoirs, two of which consist of descriptions of new material, while the third is occupied by a revision of the Ungulata. The second, with the exception of a few supplementary pages on the Ungulates, and descriptions of two new species of Carnivora, is entirely devoted to the Edentata.

In the first memoir are described some Dinosaurian remains from Patagonia, the first recorded from South America. The most completely known form is a member of the Sauropodous group; it is referred to the genus Titanosaurus, species of which also occur in the Wealden of the Isle of Wight and in the Lameta beds of Central India; but since these are only known by caudal vertebræ, it seems very doubtful whether there is sufficient evidence to establish the generic identity of the South American species with them. Nevertheless the existence of a gigantic Sauropodous Dinosaur in Patagonia is certain; and this fact, together with the recently recorded discovery of a member of the same group in Madagascar, shows that these reptiles had extremely wide range during Jurassic and Cretaceous times in both the northern and southern hemispheres.

The second memoir deals with a number of Cetacean skulls from Patagonia. These are of great interest, both on account of the light some of them throw on the history of the group, and also because they show that the Santa Cruz beds are certainly later than the Eocene (to which they are assigned by the Argentine writers), and are probably Miocene. Physodon, a genus previously known only from teeth occurring in the Miocene and Pliocene of Belgium and England, and probably ancestral to the sperm whales (Physeter), is represented by *Physodon patagonicus*, which possessed a series of teeth in the upper jaw; these have entirely disappeared in the recent form. Another interesting species is *Prosqualodon australe*, a Squalodont remarkable for the small number of its molars and for its comparatively well-developed nasals, characters in which it approaches the Eocene Zeuglodonts more nearly than any toothed whale previously known. A primitive type of the Platanistidæ is also described. This memoir is an important addition to the history of the Cetacea, for although, as might have been expected from the age of the deposits, no light is thrown upon the difficult question of the origin of the group, the author is to be congratulated on having helped to fill some of the gaps in our knowledge of it.

The South American Ungulates appear to suffer from an extraordinary superfluity of names. Mr. Lydekker regards no less than ten generic terms as synonymous with Nesodon, and states that the number of specific names that have been applied to *Nesodon imbricatus* is countless. In the classification of the order the most important innovation is the establishment of a new sub-order, the Astrapotheria, for the reception of the Homalodontotheriidæ and the Astrapotheriidæ. It is suggested that the European genus Cadurcotherium may belong here; this seems very improbable, but if true is one of the most remarkable facts of distribution known. In the description of Astrapotherium there seems to be some doubt as to the nature of the immense upper tusks, since in one place they are said to be canines, while in the dental formula given they are put down as incisors. The sub-order Litopterna, adopted for the reception of the Proterotheriidæ and Macraucheniidæ, is regarded by the author as being intermediate between the Astrapotheria and the Perissodactyla, though not ancestral to the latter. Indeed there can be no doubt that the peculiar foot-structure of the Litopterna was acquired quite independently of the Perissodactyla, and that such points of resemblance as exist between them are merely due to parallelism of their lines of evolution, a cause of similarity often neglected.

[1] "Contributions to a Knowledge of the Fossil Vertebrates of Argentina." Parts I. and II. By R. Lydekker, F.R.S. (*Anales del Museo de la Plata*, "Palæontologia Argentina, II. and III.) Folio, La Plata. 1893-4.

Nearly half the second volume is devoted to the Glyptodontidæ. The author rejects the various subdivisions of this family suggested by Ameghino and adopted by Zittel, and refers all the species to six genera, some seventeen other generic terms being regarded as synonymous.

In this group the earlier forms are of comparatively small size, and it is only in the later (Pleistocene) deposits that such giants as *Glyptodon clavipes* and *Dædicurus clavicaudatus* are found. The same progressive increase in bulk is noticeable in other groups, *e.g.* in the Mylodonts and in the Litopterna among the Ungulates. It is not improbable that the great size of the Pleistocene species had much to do with their rapid extermination when some change in the environment took place.

The remainder of the memoir deals with the Dasypodidæ and Megatheriidæ; the latter family being given a somewhat wider scope than usual. The most interesting of the genera described is Eucholœops, which is probably ancestral to the Mylodonts and in some respects approaches Myrmecophaga.

These memoirs are illustrated by more than a hundred magnificent photographic plates, undoubtedly among the finest of their kind yet published; and while lithographic drawings by a competent artist are to be preferred for the representation of detail, such figures as those of the skeletons of Toxodon and of many of the Glyptodonts will not easily be surpassed.

The text is printed in English and Spanish in parallel columns: the English portion is unfortunately disfigured by very numerous misprints, doubtless owing to the fact that the author was compelled to entrust the correction of the proof-sheets to some person unfamiliar with the language.

THE EVOLUTION OF MODERN SCIENTIFIC LABORATORIES.[1]

THE scientific discoveries of the present century have had such a profound influence upon inventions, upon industries, and upon the comfort, health, and welfare of the people in general, that there is widespread, even if not always adequate, appreciation of the value of scientific study and investigation. But it may be doubted whether there is any proper understanding, in the minds even of the educated public, of the material circumstances which surround scientific discovery and which make it possible. The average man, if interested at all, is interested that the discovery is made, not how it is made.

In America, where men of science rely mainly upon enlightened private beneficence, and not upon governmental aid, to furnish the pecuniary resources which are essential for scientific progress, it is important that there should be some general information not only regarding the results of scientific work, but also regarding the external material conditions necessary for the fruitful prosecution of such work.

At the present day the systematic study and advancement of any physical or natural science, including the medical sciences, requires trained workers who can give their time to the work, suitably constructed work-rooms, an equipment with all of the instruments and appliances needed for the special work, a supply of the material to be studied, and ready access to the more important books and journals containing the special literature of the science.

All of these conditions are supplied by a well-equipped and properly organised modern laboratory. Such laboratories are, with the partial exception of the anatomical laboratory, entirely the creation of the present century, and for the most part of the last fifty years. They have completely revolutionised during the past half-century the material conditions under which scientific work is prosecuted. They are partly the result, and in larger part the cause, of that rapid progress of the physical and natural sciences which characterises the era in which we are living.

The evolution of the modern laboratory still awaits its historian. It is not difficult to find incidental references to historical facts bearing upon this subject. The development of the chemical laboratory has been traced with some fulness. But it is curious that there is no satisfactory monographic treatment of the general subject of the historical development of scientific laboratories. The subject seems to me an attractive one. It would surely be interesting to trace the development of the teaching and the investigating laboratory back to its beginnings, to learn about the material circumstances under which the physicists, the chemists, the morphologists, and physiologists of former generations worked. What share in the development of laboratories had the learned academies of the Renaissance and of the subsequent centuries? What share had public and private museums and collections of instruments of precision? What share had the work of the exact experimentalists, beginning with Galileo, of physicians, of the alchemists, and of the apothecaries? What individuals, universities, corporations, and governments were the pioneers in the establishment of laboratories for the various physical and natural sciences? The detailed consideration of these and many other questions pertinent to the subject would make an interesting and valuable historical contribution.

There is evidence that in Alexandria, under the early Ptolemies in the third century before Christ, there existed State-supported institutes, in which students of man and of nature could come into direct personal contact with the objects of study, and by the aid of such appliances as were then available could carry on scientific investigations. The practical study of anatomy, physiology, pathology, and other natural sciences was here cultivated. We are very imperfectly informed as to the results and the material circumstances of this remarkable period in the history of science. We know that after about a century of healthy activity the Alexandrian school gradually sank into a place for metaphysical discussions.

Fifteen hundred years elapsed before we next find any record of the practical study of a natural science. In 1231, the great Hohenstaufen, Frederick the Second, who has been called the most remarkable historic figure of the Middle Ages, commanded the teachers at Salernum diligently to cultivate the practical study of anatomy. After the passage of this edict occasional dissections of the human body were made, but it cannot be said that there was any diligent cultivation of anatomy on the part either of teachers or of students during the following two centuries.

In the latter half of the fifteenth century there developed that active interest in the practical study of human anatomy which culminated in the immortal work of Vesalius, published in 1543. After this the study of anatomy by dissections gradually assumed in the medical curriculum that commanding position which it has maintained up to the present day.

For over six hundred years there has been at least some practical instruction in anatomy, and for over three hundred years there have existed anatomical laboratories for purposes of teaching and of investigation, although only those constructed during the present century meet our ideas of what an anatomical laboratory should be. It is a matter of no little interest, both for the history of medicine and for that of science in general, that the first scientific laboratory was the anatomical laboratory. Private laboratories for investigation must have existed from the earliest times. Doubtless Aristotle had his laboratory. But the kind of laboratory which we have on this occasion in mind is one open to students or investigators, or both. There was no branch of physical or natural science, with the exception of anatomy, which students could study in the laboratory until after the first quarter of the present century. Only in anatomy could students come into direct contact with the object of study and work with their own hands and investigate what lay below the surface.

The famous Moravian writer on education, Amos Comenius, over two hundred and fifty years ago, gave vigorous expression to the conception of living, objective teaching of the sciences. He said, "Men must be instructed in wisdom so far as possible, not from books, but from the heavens, the earth, the oaks and the beeches—that is, they must learn and investigate the things themselves, and not merely the observations and testimonies of other persons concerning the things." "Who is there," he cries, "who teaches physics by observation and experiment instead of by reading an Aristotelian or other text-book?" But how little ripe were the conditions then existing for the successful carrying out of ideas so far in advance of his times is illustrated by the very writings of the author of "Orbis Pictus" and "Lux in Tenebris."

It would lead too far afield to trace in detail on this occasion the development of physical and of chemical laboratories, but on account of the intimate connection between the development of physics and chemistry and that of medicine, especially of more

[1] An address delivered at the opening of the William Pepper Laboratory of Clinical Medicine, Philadelphia, December 4, 1895, by Prof. William H. Welch.

exact experimental work in the medical sciences, a few words on this subject will not be out of place.

Methodical experimentation in the sciences of nature was definitely established by Galileo, and was zealously practised by his contemporaries and successors in the seventeenth century. It was greatly promoted by the foundation during this century of learned societies, such as the Accademia dei Lincei and the Accademia del Cimento in Italy, the Collegium Curiosum in Germany, the Académie des Sciences in Paris, and the Royal Society in England. Much of the classical apparatus still employed in physical experiments was invented at this period. Experimental physics from the first acquired a kind of fashionable vogue, and this aristocratic position it has ever since maintained among the experimental sciences. These sciences must concede to physics that commanding position which it has won by the genius of the great natural philosophers, by the precision of its methods and the mathematical accuracy of its conclusions, and by the fundamental nature and profound interest and importance of its problems. The debt of the medical sciences to the great experimental physicists, from Kepler and Galileo and Newton down to Helmholtz, is a very large one, larger than is probably appreciated by medical men who have not interested themselves in the history of experimental and precise methods in medicine.

There existed in the last century cabinets of physical apparatus to be used in demonstrative lectures, but they were very inadequate, and suitable rooms for experimental work scarcely existed. It was not until about the middle of the present century that we find the beginnings of the modern physical laboratory. Lord Kelvin, then William Thomson, established a physical laboratory in the University of Glasgow about 1845 in an old wine-cellar of a house. He tells us that "this, with the bins swept away, and a water supply and sink added, served as a physical laboratory for several years." It was as late as 1863 that Magnus opened in Berlin his laboratory for experimental physical research. Since 1870 there has been a rapid development of those splendid physical institutes which are the pride of many universities.

Humbler but more picturesque was the origin of the chemical laboratory. This was the laboratory of the alchemist searching for the philosopher's stone. In the painter's canvas we can still see the vaulted, cobwebbed room with its dim and mysterious light, the stuffed serpent, the shelves with their many-coloured bottles, the furnace in the corner with the fire glowing through the loose bricks, the fantastic alembics, the old alchemist in his quaint arm-chair reading a huge, worm-eaten folio, and the assistant grinding at the mortar. Fantastic and futile as it all may seem, yet here was the birth of modern chemistry. The alchemists were the first to undertake the methodical experimental investigation of the chemical nature of substances. No more powerful stimulus than the idea of the philosopher's stone could have been devised to impel men to ardent investigation. But search for gold was not all that inspired the later alchemists Paracelsus, the alchemist, that strange but true prophet of modern medicine as he was of modern chemistry, said, "Away with these false disciples who hold that this divine science, which they dishonour and prostitute, has no other end but that of making gold and silver. True alchemy has but one aim and object, to extract the quintessence of things, and to prepare arcana, tinctures, and elixirs which may restore to man the health and soundness he has lost." And again he says of the alchemists, "They are not given to idleness nor go in a proud habit or plush or velvet garments, often showing their rings upon their fingers, or wearing swords with silver hilts by their sides, or fine and gay gloves upon their hands, but diligently follow their labours, sweating whole days and nights by their furnaces. They do not spend their time abroad for recreation, but take delight in their laboratory. They wear leather garments with a pouch and an apron wherewith to wipe their hands. They put their fingers among coals and into clay, not into gold rings."

During the seventeeth and eighteenth centuries the doctrines and work of the alchemists had profound influence upon medicine. Alchemy was not completely overthrown until Lavoisier gave the death-blow to the phlogistic theory of Stahl. But for a considerable time before Lavoisier introduced the new spirit into chemistry, its methods and its problems were gradually approaching those of modern times. It was, however, over thirty years after the tragic death of Lavoisier before the first chemical laboratory in the modern sense was established. One cannot read without combined feelings of wonder and pity of the incommodious, forlorn, and cramped rooms in which such men as Scheele and Berzelius and Gay-Lussac worked out their memorable discoveries. Liebig has graphically described the difficulties encountered by the student of that day who wished to acquire practical training in chemistry. With some of the apothecaries could be obtained a modicum of practical familiarity with ordinary chemical manipulations, but Sweden and France were the centres for those with higher aspirations.

It was the memory of his own experiences which led Liebig, immediately after he was appointed professor of chemistry in Giessen in 1824, to set about the establishment of a chemical laboratory. Liebig's laboratory, opened to students and investigators in 1825, is generally stated to be the first modern public scientific laboratory. Although, as we shall see presently, this is not quite correct, it is certain that Liebig's laboratory was the one which had the greatest influence upon the subsequent establishment and organisation not only of chemical laboratories, but of public scientific laboratories in general. Its foundation marks an epoch in the history of science and of scientific education. This laboratory proved to be of great import to medical science, for it was here, and by Liebig, that the foundations of modern physiological chemistry were laid.

The significance of this memorable laboratory of Liebig is not that it was a beautiful or commodious or well-equipped laboratory, for it possessed none of these attributes—indeed, it is said to have looked like an old stable—but that here was a place provided with the needed facilities and under competent direction, freely opened to properly prepared students and investigators for experimental work in science.

The chemical laboratories of to-day are, in general, the best organised and the best supported of scientific laboratories.

The need of establishing physiological laboratories was recognised several years before the foundation of Liebig's laboratory. The important results to be derived from the application of the experimental method to the study of vital phenomena had been demonstrated first and most signally by Harvey, and after him by many experimenters. The fecundity of exact experimentation by physical and chemical methods applied to the phenomena of life had been shown by the classical researches of Lavoisier on respiration and animal heat. Magendie had entered upon that remarkable scientific career which entitles him to be regarded as the founder of modern experimental physiology, pathology, and pharmacology.

In 1812, Gruithuisen, who, after the custom of the times, filled an encyclopædic chair, being professor in Munich of physics, chemistry, zootomy, anthropology, and later of astronomy, published an article advocating the establishment of physiological institutes. In 1823, Purkinje, one of the most distinguished physiologists of this century, accepted the professorship of physiology in Breslau, this being the first independent chair of physiology in any German university. In 1824, Purkinje succeeded in establishing a physiological laboratory, which therefore antedates by one year Liebig's chemical laboratory in Giessen, although it cannot be said to have exercised so great an influence upon the organisation of scientific laboratories in general as did the latter. In 1840, Purkinje obtained a separate building for his laboratory.

With two or three exceptions, all of the separate physiological laboratories worthy of the name have been established since the middle of the present century. Bernard, that prince of experimenters, worked in a damp, small cellar, one of those wretched Parisian substitutes for a laboratory which he has called "the tombs of scientific investigators." There can be no greater proof of the genius of Bernard than the fact that he was able to make his marvellous discoveries under such obstacles and with such meagre appliances. France was long in supplying her scientific men with adequate laboratory facilities, but no more unbiassed recognition of the value and significance of the German laboratory system can be found than in the reports of Lorain, in 1868, and of Wurtz, in 1870, based upon personal study of the construction and organisation of German laboratories.

Of modern physiological laboratories, the one which has exerted the greatest and most fruitful influence is unquestionably that of the late Prof. Ludwig in Leipzig. This unequal position it has won by the general plan of its organisation, its admirable equipment, the number and importance of the discoveries there made, its development of exact methods of experimentation, the

personal character and genius of its director, and the number of experimenters there trained from all parts of the civilised world.

To-day every properly equipped medical school has its physiological laboratory. This department is likely to continue to hold its place as the best representative of exact experimental work in any medical science. A good knowledge of physiology is the best corrective of pseudo-scientific, irrational theories and practice in medicine.

Physiological chemistry has been an important department of research for over half a century, but it is only within recent years that there have been established independent laboratories for physiological chemistry. A large part of the work in this branch of science has been done hitherto in laboratories of general chemistry, of physiology, of pathology, and of clinical medicine. A physiological laboratory cannot well be without a chemical department, and the same is true of several other medical laboratories; but it seems to me that physiological chemistry has won its position as an independent science, and will be most fruitfully cultivated by those who with the requisite chemical and biological training devote their entire time to it. The usefulness of independent laboratories for physiological chemistry has been shown by the work done in Hoppe-Seyler's laboratory in Strassburg since its foundation in 1872. This was the first independent laboratory of physiological chemistry.

The first pathological laboratory was established by Virchow, in Berlin, in 1856. About this time he wrote: "As in the seventeenth century anatomical theatres, in the eighteenth clinics, in the first half of the nineteenth physiological institutes, so now the time has come to call into existence pathological institutes, and to make them as accessible as possible to all." It cannot be doubted that the time was fully ripe for this new addition to medical laboratories. Virchow secured his laboratory as a concession from the Prussian Government upon his return from Würzburg to Berlin. Virchow's laboratory has been the model as regards general plan of organisation for nearly all pathological laboratories subsequently constructed in Germany and in other countries. It embraced opportunities for work in pathological anatomy, experimental pathology, and physiological and pathological chemistry. This broad conception of pathology and of the scope of the pathological laboratory as including the study, not only of diseased structure, but also of disordered function, and as employing the methods, not only of observation, but also of experiment, should never be lost sight of.

The first to formulate distinctly the conception of pharmacology as an experimental science distinct from therapeutics and closely allied by its methods of work and by many of its problems to physiology, was Rudolph Buchheim. This he did soon after going to Dorpat in 1846 as extraordinary professor of materia medica, and it was apparently not long after he there became ordinarius in 1849 that he established a pharmacological laboratory in his own house and by his private means. Later, this laboratory became a department of the University, and developed most fruitful activity. Buchheim's laboratory was the first pharmacological laboratory in the present acceptation of this term. The conception of pharmacology advocated by Buchheim has been adopted in all German universities, and in not a few other universities; but it cannot be said to have been as yet generally accepted in the medical schools of this country and of Great Britain, although it seems destined to prevail.

The medical science which was the latest to find domicile in its own independent laboratory is hygiene. To Pettenkofer belongs the credit of first establishing such a laboratory. Since 1847 he had been engaged with hygienic investigations, and in 1872 he secured from the Bavarian Government the concession of a hygienic institute. This admirably equipped laboratory was opened for students and investigators in 1878. By this time Koch had already begun those epochal researches which, added to the discoveries of Pasteur, have introduced a new era in medicine. The introduction by Koch of new methods of investigating infectious diseases and many hygienic problems became the greatest possible stimulus for the foundation of laboratories of hygiene and bacteriology, and to some extent also of laboratories of pathology. The results already achieved by these new methods and discoveries in the direction of prevention and cure of disease, and the expectation of no less important results in the future, constitute to-day our strongest grounds of appeal to governments and hospitals and medical schools and the general public for the establishment and support of laboratories where the nature, the causes, the prevention, and the cure of disease shall be investigated. You have established in Philadelphia, and in connection with the Johns Hopkins University, the first hygienic laboratory in America, housed in its own building and assured, I believe, of a future of great usefulness.

It is apparent, from the brief and imperfect outline which I have presented of the evolution of modern scientific laboratories, that the birthplace of these laboratories, regarded as places freely open for instruction and research in the natural sciences, was Germany. Such laboratories are the glory to-day of German universities, which possess over two hundred of them. By their aid Germany has secured since the middle of the present century the palm for scientific education and discovery.

Great scientific investigators are not limited to any country or any time. There are those of surpassing ability who will make their own opportunity and will triumph over the most discouraging environment. This country and every civilised country can point to such men, but they are most exceptional. The great majority of those even with the capacity for scientific work need encouragement and opportunity. We now have sufficient knowledge of the workings of scientific laboratories to be able to assert that in general where the laboratory facilities are the most ample and the most freely available, there are developed the largest number of trained workers, and there the discoveries are the most numerous and the most important. At the present day no country, no university, and no medical school can hold even a respectable place in the march of education and progress unless it is provided with suitable laboratories for scientific work.

A properly equipped and properly conducted scientific laboratory is a far more expensive institution than is usually conceived. It must be suitably domiciled either in a separate building or in rooms commodious and well-lighted. The outside architectural features are of secondary importance. The instruments and appliances necessary for exact observation and experiment, even in those sciences which apparently require the least, are numerous and costly. A working library, containing the books and sets of journals most frequently consulted, is most desirable, if not absolutely indispensable. The director of the laboratory should be a man of ability and experience, who is a master in his department of science. He must have at least one assistant, who is preferably a young man aiming to follow a scientific career. A person of no small value in the successful working of the laboratory is the intelligent janitor or "diener," who can be trained to do the work of a subsidiary assistant and can be entrusted with the care and manipulation of instruments. There must be funds for the purchase of fresh supplies and new instruments when needed. The running expenses of a first-class laboratory are not small.

But, costly as may seem the establishment and support of a good laboratory, the amount of money expended for laboratories would seem to us ridiculously insignificant if we could estimate the benefits to mankind derived from the work which has been done in them. Wurtz has truly said of the money required for laboratories, "It is a capital placed at a high rate of interest, and the comparatively slight sacrifice imposed upon one generation will bring to following generations increase of well-being and knowledge."

The educational value of the laboratory cannot well be overestimated. For the general student this is to be found primarily in the development of the scientific habit of thought. He learns that to really know about things it is necessary to come into direct contact with them and study them. He finds that only this knowledge is real and living, and not that which comes from mere observation of external appearances, or from reading or being told about things, or, still less, merely thinking about them.

The problem of securing for the student of medicine the full benefits of laboratory instruction in the various medical sciences is a difficult one, and cannot, I believe, be solved without considerable readjustment of existing schemes of medical teaching; but this subject is one which I cannot attempt to consider here.

The whole face of medicine has been changed during the last half-century by the work of the various laboratories devoted to the medical sciences. Anatomy, physiology and pathology now rank among the most important of the sciences of nature. They have been enriched with discoveries of the highest significance and value not only for medicine, but also for general biology. Although we have not penetrated, and perhaps may never penetrate, the mystery of life, we are coming closer and closer to an understanding of the intimate structure and the

fundamental properties of living matter. We already know that living matter is not that homogeneous, formless substance which, not many years ago, it was believed to be, but that it possesses a complex organisation.

Practical medicine has been profoundly influenced by the unparalleled development of the medical sciences during the last fifty years, and especially during more recent years. Scientific methods have passed from the laboratory to the hospital. Cases of disease are now studied with the aid of physical and chemical and microscopical and bacteriological methods. The diagnosis of disease has thereby been greatly advanced in precision, and if Boerhaave's motto, *qui bene diagnoscit, bene medebitur*, be true, there should be a corresponding advance in the results of the treatment of disease. Whether or not this dictum of the old master be true—and I have serious doubts as to its entire truth—it cannot be doubted that great progress has been made in medical, and especially in surgical treatment as a result of scientific discoveries, although the treatment of disease still rests, and will doubtless long continue to rest, largely upon empirical foundations.

We are assembled here to-day to assist at the opening of a laboratory which gives the fittest and strongest possible expression to the influence of scientific work upon practical medicine. The generous founder has marked with characteristic insight the direction in which the current is setting.

The conception of a thoroughly equipped laboratory as an integral part of a hospital and intended for the study and investigation of disease is of recent origin. The germs of this idea, however, may be traced back to such men as Hughes Bennett and Beale in Great Britain, and to Frerichs and Traube in Germany, who in their hospital work made fruitful application of microscopical, chemical, and experimental methods. A little over ten years ago, von Ziemssen, in Munich, established a well-conceived clinical laboratory, containing a chemical, a physical, and a bacteriological department, a working library, and rooms for practical courses and the examination of patients. A similar laboratory was secured by Curschmann in Leipzig in 1892.

The growing recognition of the need of such laboratories is the result of the great progress in scientific medicine during recent years. The thorough clinical examination of many cases of disease now requires familiarity with numerous technical procedures, physical, chemical, microscopical, and bacteriological. The laboratory outfit required simply for routine clinical examinations is considerable. A microscope and a few test tubes and chemical reagents for simple tests of the urine no longer suffice. As illustrations of this, I call attention to the clinical value of examinations of the blood, of the contents of the stomach, of fluids withdrawn from the serous cavities, of the sputum and various secretions, of fragments of tissue removed for diagnosis. Such examinations require much time, trained observers, and considerable apparatus. To secure for the patients the benefits in the way of diagnosis, prognosis, and treatment to be derived from these methods of examination, a hospital should be supplied with the requisite facilities.

A hospital, and especially one connected with a medical school, should serve not only for the treatment of patients, but also for the promotion of knowledge. Where this second function is prominent, there also is the first most efficiently and intelligently carried out. Herein we see the far-reaching beneficence of a laboratory, such as this one, thoroughly equipped to investigate the many problems which relate to clinical medicine.

The usefulness of an investigating laboratory in close connection with a hospital has already been abundantly demonstrated. Chemical studies, more particularly those relating to metabolism in various acute and chronic affections, microscopical and chemical investigations of the blood and bacteriological examinations of material derived directly from the patient, may be mentioned as directions in which researches conducted in hospital laboratories have yielded important results and will garner still richer harvests in the future.

There need be no conflict between the work of clinical laboratories and that of the various other medical laboratories. Each has its own special field, but it is not necessary or desirable to draw around these fields sharp boundary lines beyond which there shall be no poaching. It will be a relief to pathological and other laboratories to have certain examinations and subjects relating directly to practical medicine consigned to the clinical laboratory, where they can receive fuller and more satisfactory consideration. The subject-matter for study in the clinical laboratory is primarily the patient and material derived from the patient. Anatomical, physiological, pathological, pharmacological, and hygienic laboratories must concern themselves with many problems which have apparently no immediate and direct bearing upon practical medicine. In the long run their contributions are likely to prove most beneficial to medicine if broad biological points of view, rather than immediate practical utility, are their guiding stars. The clinical laboratory will concern itself more particularly with questions which bear directly upon the diagnosis and the treatment of disease.

To the small number of existing well-equipped clinical laboratories the William Pepper Laboratory of Clinical Medicine is a most notable addition. It is the first laboratory of the kind provided with its own building and amply equipped for research in this country, and it is not surpassed in these respects by any in foreign countries. It is intended especially for investigation and the training of advanced students. It is a most worthy memorial of the father of its founder.

William Pepper the elder was a very distinguished physician and trusted consultant of Philadelphia, for many years an attending physician at the Pennsylvania Hospital, where he was a clinical teacher of great influence, and for four years the professor of the theory and practice of medicine in this University. He belonged to that remarkable group of American physicians, trained under Louis, who brought to this country the best methods and traditions of the French school of medicine at the time of its highest glory. His diagnostic powers are said to have been remarkable. With his broad sympathies, his lofty ideals, and his active and enlightened efforts for the promotion of clinical medicine, how he would have welcomed such opportunities as will be afforded by this laboratory to contribute to a better knowledge of the nature, the diagnosis, and the treatment of disease!

Our country has until within a very few years been deprived of the encouragement and opportunities for original investigations in the medical sciences afforded by large and thoroughly equipped laboratories. We can still count upon the fingers of one hand our medical laboratories which are comparable in their construction, organisation and appliances to the great European laboratories. Notwithstanding these obstacles, there have been American physicians of whose contributions to medical science we may feel proud.

But a new era has dawned. Of that we are witnesses here to-day. The value of medical laboratories is now widely recognised among us. To those of us who appreciate the underlying currents in medicine, who follow with eager interest the results of the almost feverish activities in foreign laboratories, who recognise the profound interest and importance of the many medical problems which await only patient investigation and suitable facilities for their solution, and who would like to see our country take the prominent position it should in these investigations, our laboratories may seem slow in coming, but they will in time be provided by enlightened benevolence. The individual or institution or hospital which contributes to the establishment of a good laboratory devoted to any of the medical sciences merits in unusual degree the gratitude of all medical men; yes, of every true friend of humanity. Such gratitude we feel for the generous and public-spirited founder of this laboratory, who has contributed largely to the advancement of medicine in this country, and of whose splendid services to this university I need not speak in this presence.

I congratulate this city and this university and this hospital upon the important addition made by this laboratory to higher medical education and the opportunities for scientific work in this country. May the enlightened aims of the founder, and the hopes of all interested in the promotion of medicine in this country, be fulfilled by the scientific activities which will now begin in the William Pepper Laboratory of Clinical Medicine.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—At the Encænia this year (June 24) it will be proposed to confer the honorary degree of D.C.L. upon Sir Archibald Geikie, among others.

The Rolleston memorial prize has been awarded to Mr. Horace M. Vernon, for his dissertations on (1) the effect of environment

on the development of Echinoderm larvæ, (2) the relation of the respiratory exchange of cold-blooded animals to temperature, (3) the respiratory exchange of the lower marine invertebrates.

CAMBRIDGE.—The Reade Lecture will be given on Wednesday, June 10, in the Anatomy Theatre, by Prof. J. J. Thomson. The subject for this year is "Röntgen Rays."

Prof. Lewis announces a course of lectures and demonstrations in Crystallography, to be given daily during the Long Vacation, beginning on July 8.

A new syndicate, to take the place of that rejected by the Senate last term, has been nominated to consider the question of degrees for women. It consists of the Vice-Chancellor, Dr. C. Taylor, Mr. W. Chawner, Dr. V. Stanton, Dr. F. W. Maitland, Dr. L. E. Shore, Dr. M. James, Prof. Robinson, Mr. J. W. Cartmell, Mr. R. D. Roberts, Mr. W. N. Shaw, F.R.S., Mr. A. W. W. Dale, Mr. A. N. Whitehead, and Mr. A. Berry. This list includes only three members of the Council, and is said to be younger and less partisan than the rejected syndicate.

Meanwhile Dr. Hobson, F.R.S. of Christ's College, has issued a fly-sheet proposing that, as the balance of opinion in the Senate is against the admission of women to full membership, it might suffice to confer on them the "title" of B.A. by diploma. The title, he thinks, should be open to women who have studied at recognised colleges other than Newnham and Girton, provided they pass one of the Tripos examinations. It remains to be seen what reception will be given by Newnham and Girton to this proposal for an encroachment on their monopoly.

The Statute authorising the University to make provision for Advanced Students has received the approval of the Queen in Council. A guide to the courses of advanced study and research at present arranged for, has been prepared by Dr. Donald MacAlister, Tutor of St. John's College, and will be issued in June by the University Press.

A STRENUOUS and persistent effort to endow Barnard College (for women) has just been successfully made. The college some months ago purchased a site adjoining the new site of Columbia University, paying 160,000 dols., of which sum 100,000 dols. remained on mortgage. An unknown benefactor offered to pay the amount of this mortgage, provided others would contribute an equal amount by May 10. It is now known that this benefactor is Mrs. Van Wyck Brinkerhoff. Another unknown donor, who turns out to be Mr. John D. Rockefeller, offered 25,000 dols.; others contributed smaller amounts, but on the morning of Saturday, May 9, there was still a deficit of 23,000 dols. By strenuous efforts, however, this was secured during the day. Among the contributors were Mr. Seth Low, Mrs. F. E. Hockley, and an anonymous friend, who each paid 10,000 dols., and Mr. Jacob H. Schiff, who paid 8000 dols.

WE notice that at the last meeting of the Oxfordshire County Council, held at Oxford on the 12th inst., a proposition was made to devote the sum of £2000 out of a total of £4080, arising from the Customs and Excise Duties, to the relief of the rates; but it was defeated by a large majority. At a meeting of the East Sussex County Council, held on the same day, a resolution was carried that the whole of the funds available for the purposes of technical education be in future devoted to this object, instead of £5000 as heretofore. A similar motion was proposed at the meeting of the County Council for the North Riding of Yorkshire, held on the 6th inst. at Northallerton, and gave rise to a considerable amount of discussion, during which one councillor, a prominent member of Parliament, described the Technical Instruction Committee as the "horse-leech of the Council." Eventually an amendment, "that the County Council devote £6000 of the Local Taxation (Customs and Excise) grant for 1896-7 to technical education," was carried unanimously. By referring we find that during the financial year 1893-4 the total amount available was £6928.

THE last number of the *London Technical Education Gazette* gives some very interesting information concerning the number of scholarships and exhibitions which have been awarded by the Technical Education Board of the London County Council. The total number of the Board's scholars and exhibitioners is 1752, of whom 1154 are junior, 118 are intermediate, and 10 senior county scholars. The reports, which the Board receives at regular intervals, show that in the majority of cases the conduct and progress of the scholars are satisfactory. Some scholars have done remarkably well, especially in the case of the intermediate and senior students. In the case of a few of the junior scholars it has been found necessary to give a caution and to renew their scholarships for a short time on probation. This has in most cases been quite enough, though one or two scholarships have had to be taken away entirely. The scholarship winners are left free to choose any school that appears on the Board's published list. The result is, that at present 913 junior county scholars are in attendance at secondary schools, and 241 at upper standard public elementary schools. The secondary schools most commonly chosen are Roan School, Owen's School, Alleyn's School, and Aske's School, Hatcham, at all of which there are over fifty scholars and exhibitioners. The intermediate county scholars are now attending all the principal secondary schools of London, and some are in attendance at institutions of university rank, after having been for a year at a secondary school. The senior county scholars have joined some of the principal universities of the country, two being at Cambridge, at Clare and Sidney Sussex Colleges, and two at Newcastle in connection with the University of Durham.

THE report of the Technical Instruction Committee, which was presented to the May meeting of the West Riding Council, supplies abundant evidence of the good work which has been done during the session which is being completed. As would be expected, a very important place is occupied by the Committee's consideration of the Education Bill, an excellent summary of which forms the opening part of the report. The conclusions to which the Committee have come are that it would be undesirable for the duties connected with the administration of elementary education to be placed upon County Councils and for any expenditure in reference to such instruction to be thrown upon the County rates. The proposals with reference to secondary education are very favourably regarded, but it is pointed out that already the expenditure exceeds the income provided under the Local Taxation (Customs and Excise) Act, 1890, and must necessarily increase; and hence, if the County Council is to utilise the extended powers and carry out the duties to be conferred by the Bill, it is essential that adequate moneys be provided by Parliament. They further recommend that the Education Department should not be endowed with additional powers of control over the County Council in respect of the expenditure of funds provided under the above-mentioned Act, or out of the County rate for purposes of secondary education. We would call especial attention to certain supplementary regulations which have been adopted by the Committee as to the award and tenure of technical exhibitions. In future the Committee will, in considering recommendations for exhibitions, have regard to the preparatory work already done by the student, and as a rule no technical exhibition will be awarded unless evidence can be given by the candidate that he possesses a satisfactory knowledge of the principles of those sciences on which such technological subject is based; for instance, an exhibition in electric lighting and power distribution would in no instance be awarded to a student possessing an inadequate knowledge of applied mechanics and electricity and magnetism. No exhibition will usually be granted for a study of a *technological* subject to an applicant under eighteen years of age. These are but examples of a number of really wise provisions.

SCIENTIFIC SERIALS.

American Journal of Science, May.—Carbon and oxygen in the sun, by J. Trowbridge. The peculiar bands of the arc spectrum of carbon can be detected in the sun's spectrum. They are, however, almost obliterated by the overlying absorption lines of other metals, especially by the lines due to iron. In order to form an idea of the amount of iron in the atmosphere of the sun which would be necessary to obliterate the banded spectra of carbon, the author compared the spectrum of carbon with that of carbon dust and a definite proportion of iron distributed uniformly through it. The carbon dust and iron reduced by hydrogen was formed into pencils suitable for forming the voltaic arc, and containing 28 per cent. of iron to 72 per cent. of carbon. Photographs were taken of the portion of the solar spectrum which contains traces of the peculiar carbon band lying at wave-length 3883·7. The pure carbon-banded spectrum was photographed on the same plate immediately below the solar spectrum, and the spectrum of the mixed iron and carbon immediately below this. It was found that the iron present almost completely obliterated the carbon, and this fact tells in favour of

the supposition that the traces of bands observed are true carbon bands. The author also investigated the spark spectrum of oxygen produced by a dynamo and transformer, and compared the bright lines found with the solar iron lines found in the same positions. The result showed that the oxygen lines, if present in the sun, are not sufficient to cover even the faintest iron absorption lines. Still, the author inclines to the view that the sun's light is due to carbon vapour in an atmosphere of oxygen.—On the determination of the division errors of a straight scale, by H. Jacoby. The author compares every division, and set of divisions, microscopically with every division on a duplicate scale. This is Gill's method. But he improves it by counting the "weight" of each observation according to its true value, instead of assigning the same weight to all readings without distinction.—Röntgen rays not present in sunlight, by M. Carey Lea. The author proved this by trying to obtain radiographs from the sun's light through one hundred leaves of a book, or through aluminium foil. No trace of Röntgen rays was found in sunlight, nor was any found in the light from a Welsbach incandescent gas burner.—On numerical relations existing between the atomic weights of the elements, by M. Carey Lea. It has already been shown that elements whose ions are always colourless can be arranged in vertical lines so that the horizontal lines contain each a natural group. Also that the elements whose ions are always coloured, form series with the atomic weights immediately following one another. If the atomic weights in the first vertical column are subtracted from those in the second, the second from the third, and so on, certain standard differences are found to recur. One of these is about 16, the other about 46, and the third about 88. The elements with ions always coloured are outside of this rule. Their behaviour is altogether anomalous. The colourless elements, beginning with hydrogen, fall into four series of nine each, interrupted by four coloured groups, and followed by an alternate series, Hg, Tl, Pb, Bi, Th and U.

Bulletin of the American Mathematical Society, April.—A two-fold generalisation of Fermat's theorem, a paper presented to the Society at its February meeting, is stated by the author, Prof. E. H. Moore, to be one-fold generalisations of two known theorems, of which one may be looked at as a theorem in the ordinary Gauss-congruence theory, while its generalisation is a theorem in the Galois-field theory. It is naturally highly symbolical. Prof. J. Pierpont gives an interesting and valuable note on the Ruffini-Abelian theorem. Gauss, in 1799, rigorously established the fundamental theorem that every equation of degree n possesses n roots real or imaginary. When n is less than five, it had been long known that these roots could be expressed as explicit algebraic functions of the coefficients. Between the years 1799 and 1813 an Italian mathematician, Ruffini, made several attempts to establish the justice of the doubts that the roots of equations of degree greater than four possessed this property. His reasoning, however, has not been judged to be conclusive, and the question remained open until the publication of Abel's argument in 1826. Prof. Pierpont, in addition to the preceding statement, gives several other historical notes, and states that his object is to give a demonstration of the theorem which shall be as direct and *self contained* as possible. In addition he gives demonstrations, one of which is a modification of Ruffini's form, and the other Kronecker's modification of Abel's form.—On certain subgroups of the general projective group, is a paper, read before the January meeting, by the author, Prof. Henry Taber. It is on the lines of recent previous papers by the author in the *Bulletin*, the *Proceedings* of the London Mathematical Society, and the *Mathematische Annalen*. The "Notes" give the courses for the summer semester at Berlin and Göttingen. A synopsis is also published of the first volume of a work of great originality, viz. the Geometrie der Berührungstransformationen, Dargestellt von Sophus Lie und G. Scheffers. A long list of new publications closes the number.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 30.—"On some Palæolithic Implements found in Somaliland by Mr. H. W. Seton-Karr." By Sir John Evans, K.C.B., F.R.S.

In the course of more than one visit to Somaliland, Mr. Seton-Karr noticed, and brought home for examination, a number of worked flints, mostly of no great size, which he laid before the Anthropological Section of the British Association, at the meeting last year at Ipswich.[1] Although many of these specimens were broad flat flakes trimmed along the edges so as to be of the "le Moustier type" of M. Gabriel de Mortillet, and although the general *facies* of the collection was suggestive of the implements being of Palæolithic age, they did not afford sufficient evidence to enable a satisfactory judgment to be formed whether they undoubtedly belonged to the Palæolithic period.

On returning to Somaliland, during the past winter, Mr. Seton-Karr was fortunate enough to meet with a large number of specimens in form absolutely identical with some from the valley of the Somme and other places.

Of this identity in form there can be no doubt, and though at present no fossil mammalian or other remains have been found with the implements, there need be no hesitation in claiming them as Palæolithic. Their great interest consists in the identity of their forms with those of the implements found in the Pleistocene deposits of North Western Europe and elsewhere.

The discovery aids in bridging over the interval between Palæolithic man in Britain and in India, and adds another link to the chain of evidence by which the original cradle of the human family may eventually be identified, and tends to prove the unity of race between the inhabitants of Asia, Africa, and Europe, in Palæolithic times.

May 7.—"The Electromotive Properties of the Electrical Organ of *Malapterurus electricus*." By Francis Gotch, F.R.S., and G. J. Burch.

The conclusions drawn by the authors from the experiments on the isolated organ and on the entire uninjured fish may be summarised as follows :—

(1) The isolated organ responds to electrical excitation of its nerves by monophasic electromotive changes, indicated by electrical currents which traverse the tissue from the head to the tail end; this response commences from 0·0035″ at 30° C. to 0·009″ at 5° C. after excitation, the period of delay for any given temperature being tolerably constant.

(2) The response occasionally consists of a single such monophasic electromotive change (shock) developed with great suddenness, and subsiding completely in from 0·002″ to 0·005″, according to the temperature; in the vast majority of cases the response is multiple, and consists of a series of such changes (shocks) recurring at perfectly regular intervals, from two to thirty times (peripheral organ rhythm); the interval between the successive changes varies from 0·004″ at 30° C. to 0·01 at 5° C., but is perfectly uniform at any given temperature throughout the series.

(3) Such a single or multiple response (in the great majority of cases the latter) can also be evoked by the direct passage of an induced current through the organ and its contained nerves, in either direction heterodromous (*i.e.*, opposite in direction to the current of the response) or homodromous.

(4) The time relations of the response are almost identical whether this is evoked by nerve-trunk (indirect stimulation), or by the passage of the heterodromous induced current.

(5) There is no evidence that the electrical plate substance can be excited by the induced current apart from its nerves, *i.e.* it does not possess independent excitability.

(6) The organ and its contained nerves respond far more easily to the heterodromous than to the homodromous induced current, and the period of delay in the case of the latter response is appreciably lengthened.

(7) The peripheral organ rhythm (multiple response) varies from about 100 per second at 5° C. to about 280 per second at 35° C.

(8) One causative factor in the production of the peripheral rhythm is the susceptibility of the excitable tissue to respond to the current set up by its own activity (self-excitation).

The authors further conclude that, since each lateral half of the organ is innervated by the axis cylinder branches of one efferent nerve cell, and has no independent excitability, the specific characters of the reflex response of the organ express far more closely than those of muscle the changes in central nerve activity, and are presumably those of the activity of a single efferent nerve cell.

The single efferent nerve cell, the activity of which is thus for the first time ascertained, shows—

(*a*) A minimum period of delay of 0·008″ to 0·01″.

(*b*) A maximum rate of discharge of 12 per second.

[1] Report 1895 p 824

(*c*) An average rate of discharge of 3 to 4 per second.

(*d*) A susceptibility to fatigue showing itself in the discharge failing after it had recurred from two to five times at the above rates.

Physical Society, May 22.—Prof. Ayrton, Vice President, in the chair.—Mr. R. Appleyard read a paper on dielectrics. The author has particularly investigated the effect of temperature on dielectric resistance. He has employed for this purpose condensers insulated with mica and paraffined paper. In order to eliminate some of the effects of surface leakage, Price's guard-ring arrangement was made use of in all the experiments. The author finds that the capacity of a paraffin condenser varies irregularly with the temperature, but that to within the accuracy attainable with his instruments (1 per cent.), the capacity of a mica condenser is constant between 33° F. and 110° F. If the resistance of paraffin at a temperature t is represented by $R_t = R\alpha^t$, the mean value for log α deduced from all the author's measurements is $\bar{1}\cdot96344$. Experiments made with a parallel plate condenser with paraffin as the dielectric, show that when the temperature reaches within about 20° of the melting point the resistance rapidly falls; when melting commences there is a rapid drop, but while melting is in progress the resistance remains constant. Prof. Ayrton said he could bear witness to the extreme value of Mr. Price's device, as it completely did away with the necessity for the extreme care previously necessary to prevent errors due to surface leakage. He regretted that he had not had an opportunity of comparing the author's numbers with some obtained some years ago by Prof. Perry and himself (Prof. Ayrton).—A paper by Prof. Viriamu Jones, on the magnetic field due to an elliptical current at a point in the plane of the ellipse and within it, was taken as read. Prof. Silvanus Thompson said that this paper was of interest not only on account of the application which others might make of the author's method, but also in that the correction when applied to Prof. Jones's results brought the international ohm more nearly into accord with the true ohm. Mr. J. J. Walker said he considered that the paper was more suited to the Mathematical Society. The integration which the author reduced to elliptic integrals might be more easily performed by another method. Prof. Ayrton said that Prof. Jones's value for the true ohm was now 106·302 cm. of mercury.—Mr. Campbell read a paper on new instruments for the direct measurement of the frequency of alternating or pulsating electric currents. The author employs two arrangements, in one of which a steel wire, the tension on which is variable, and the other a steel spring of variable length, clamped at one end, are acted upon by an electro-magnet, through which the periodic current is passed. The tension or length, as the case may be, is varied till maximum resonance is obtained, a small contact piece being employed to detect when this occurs. The instrument exhibited was capable of measuring the frequency of periodic currents of from 40 to 150 double vibrations per second. Mr. Watson said he thought that in the case of the steel spring there would be a considerable temperature correction, and he suggested a method by which this might be compensated. Mr. Blakesley asked if the author had found that the spring became magnetised and thus gave the octave. Mr. Carter asked whether elastic fatigue influenced the results, and said that a synchronous motor and a speed indicator could be used to measure the frequency. Prof. Silvanus Thompson suggested that it might be preferable to employ a polarised apparatus, since to avoid the impression of forced vibrations on the spring it was better, as was done in the case of tuning-forks, to make it massive. It had been found in other cases, such as in Hughes' telegraph and the telephone, that better results were obtained with polarised apparatus. He (Prof. Thompson) had used a telephone, placed anywhere near a magnet traversed by the periodic current, together with a tuning-fork, which gave beats with the note produced by the telephone, to measure frequencies. The variations in frequency ordinarily met with in practice were much greater than was generally suspected. Mr. Blakesley said he considered that the advantage of the author's instrument over a telephone and tuning fork was that it was continuously variable over a large range. Mr. Enright asked if the author had been troubled by the spring or wire breaking into overtones. In some experiments in which rather long wires were used, he had been troubled in this way. Prof. Ayrton said that he did not think that it was possible to get the wire or spring to respond to the octave unless the alternating current contained a component of the frequency of the octave; in fact, he had himself used such a stretched string as a wave analyser. He had used a telephone to prove that the note given by a hissing alternate current arc corresponded in frequency to that of the current. In the instrument used by Prof. Perry and himself, a polarised arrangement was always employed, since the alternating current was passed either through a wire in a constant magnetic field, or through an electro-magnet which acted on a wire through which a constant current was passed. The author, in his reply, said that the instrument responded, though feebly, to the octave, and this response might be made use of to check the accuracy of the scale.—The Society then adjourned till June 12.

Entomological Society, May 6.—Prof. Meldola, F.R.S., President, in the chair.—Mr. Champion exhibited specimens of *Amara famelica*, Zimm., from Woking, Surrey, a recent addition to the British list. He also exhibited, on behalf of Mr. Dolby-Tyler, a series of *Eburia quadrinotata*, Latr., from Guayaquil, Ecuador, showing variation in the number of the raised ivory-white lines on the elytra.—Mr. Horace Donisthorpe exhibited a specimen of *Pterostichus gracilis* with three tarsi on one leg, taken near Weymouth last April.—Mr. G. T. Porritt exhibited a series of *Arctia menthrastri* which he had just bred from Morayshire ova; the ground-colour of the specimens varied from the usual white, through shades of yellow, to dark smoky-brown.—Mr. Merrifield exhibited specimens of *Gonepteryx rhamni* bred from larvæ found in North Italy and Germany, the pupæ of which had been subjected to various temperatures. He stated that high temperature appeared to cause an increase of yellow scales in the female, and low temperatures generally reduced the size of the orange discal spot on the forewings of both sexes.—Mr. Merrifield said that the effects on the imago produced by temperature were being made the subject of systematic research by Prof. Weismann, Dr. Standfuss, Mr. E. Fischer, and others.—Mr. Kirkaldy exhibited and made remarks on ova of *Notonecta glauca* var. *furcata*.—Mr. Tutt exhibited living larvæ of *Apamea ophiogramma*, together with the grass on which it was feeding.—Mr. Goss read a communition from Mr. E. Meyrick on the subject of Prof. Radcliffe-Grote's criticisms, contained in his paper published in the *Proceedings* of the Society, 1896, pp. x.-xv., on the use of certain generic terms by Mr. Meyrick in writing on the Geometridæ.—Mr. McLachlan opened a discussion as to the best means of preventing the extinction of certain British butterflies. He referred to the extinction of *Chrysophanus dispar*, *Lycæna acis*, and *Aporia cratægi*, and to the probable extinction, in the near future, of *Papilio machaon*, *Melitæa cinxia*, and *Lycæna arion*. He stated that one of the objects he had in view in bringing this matter forward was to see whether some plan could not be devised to protect those specially localised species which were apparently in danger of being exterminated by over-collecting.—Prof. Meldola said he fully sympathised with the remarks of Mr. McLachlan, and thought that a resolution passed by the Society, possibly in conjunction with kindred Societies, might produce some effect. Mr. Goss stated that *Papilion machaon*, although apparently doomed to extinction in its chief locality in Cambridgeshire (Wicken Fen), would probably linger on in the country in smaller fens, such as Chippenham, where the larvæ had been found feeding on *Angelica sylvestris*. It would certainly survive in the Norfolk Broads, both from the irreclaimable nature of the fens there and the extensive range of the species in the district. He stated that *Melitæa cinxia*, although gradually disappearing from most of its old localities in the south of the Isle of Wight, was still found in the island further west, where he had seen it in numbers in May 1895. He added that *Lycæna arion* was far from extinct in Gloucestershire, and was distributed over a much wider area in the extreme south-west of England than was generally supposed.—Mr. Elwes stated that *L. arion* formerly occurred in several places on his own property in Gloucestershire, but had disappeared of late years, although not collected. Its disappearance was probably due to changes of climate.—Colonel Irby said that *L. arion* had disappeared many years ago not only from Barnwell Wold, Northamptonshire, but from another part of the county, on the estate of Lord Lilford, not accessible to the public, and that its disappearance there was no doubt caused by the destruction of the food plant and other herbage by burning the pasture, and by the grazing of sheep. Mr. Crowley, Mr. Tutt, Mr. Waterhouse, and Mr. Blandford continued the discussion.—Mr. Guy A. K. Marshall communicated a paper entitled "Notes on Seasonal Dimorphism in South African Rhopalocera."—Mr. P. Cameron communicated a paper entitled "Descriptions of new species of Hymenoptera from the Oriental Region."

Geological Society, May 13.—Dr. Henry Hicks, F.R.S., President, in the chair.—An account of a head or gateway driven into the Eastern Boundary-fault of the South Staffordshire coal field, by William Farnworth. The author described certain peculiarities observed during the driving of a head towards the fault separating the Coal-Measures and Permian rocks, from a pit situated four miles east of Walsall, at the southern extremity of the Cannock Chase coal field.—On the geographical evolution of Jamaica, by Dr. J. W. Spencer. The object of the paper was to set forth the physical and geological characteristics of Jamaica which bear upon the problem of its late high elevation and former connection with the continent, and to trace across the neighbouring seas and islands to the mainland the evidences of the former linking of Jamaica to North and South America. The first part of the paper treated of the growth of the island. The second part of the paper treated of the continental connections of Jamaica. The author gave details of the submerged plateaus and drowned valleys which are analogous to those still existing above sea-level. They indicate that the former altitude of the West Indian plateau, and some portions of the adjoining continent, reached two and a half miles. But the floors of the Mexican Gulf and Honduras and the Caribbean Sea formed low plains draining into the Pacific Ocean, for at that time the eastern region was high, while the Mexican area was generally low.—Dundry Hill: its upper portion, or the beds marked as Inferior Oolite (G 5) in the maps of the Geological Survey, by S. S. Buckman and E. Wilson. The authors gave an account of previous geological work relating to Dundry Hill, especially that which refers to the correlation of its strata. Then they described the different exposures on the hill, together with the results of various excavations carried out by quarrymen under their superintendence for the purpose of the present communication. Besides demonstrating the sequence of the strata of Dundry Hill, the authors were able to show a number of results of special interest.

Zoological Society, May 19.—Sir W. H. Flower, K.C.B., F.R.S., President, in the chair.—Mr. Sclater exhibited a daguerreotype portrait of what was believed to be the first gorilla that was ever brought alive to Europe. It was living in Wombwell's menagerie in 1855. This portrait had been lent to Mr. C. Bartlett by Mr. Fairgrieve, formerly associated with Mr. Wombwell, who had sent with it an account of the animal and its habits.—A communication was read from Mr. G. E. H. Barrett-Hamilton, on a variation in the pattern of the teeth of a specimen of the common field-vole (*Microtus agrestis*).—A second communication from Mr. Barrett-Hamilton contained remarks on the existence in Europe of two geographical races or sub-species of the common field-vole. Mr. Barrett-Hamilton considered the field-voles of England, Belgium, and the North of France, and possibly of a large part of the continent, as distinct from the Scandinavian animals, which would remain the typical *Microtus agrestis*, while the British and western continental form should be called *Microtus agrestis neglectus*, Jenyns. This view agreed with that of De Selys-Longchamps in 1847.—Mr. F. E. Beddard, F.R.S., read the third of his contributions to the anatomy of Picarian birds. The present paper related to the variations in pterylosis and in anatomy of the *Alcedinidæ*, of which he had examined specimens. Although this family was so uniform in external structure, it presented considerable differences when the pterylosis and anatomy were examined.—Mr. de Winton described a new rodent of the genus *Lophuromys* from British East Africa, which he named *L. ansorgei*.

Royal Meteorological Society, May 20.—Mr. E. Mawley, President, in the chair.—Mr. R. H. Curtis read a paper on the exposure of anemometers, in which he gave the results of a comparison of the records from the three anemometers at Holyhead, viz. the Robinson, the bridled, and the pressure-tube anemometers. It was clearly shown that the force of the wind is greatly affected by surrounding objects. The author is of opinion that for anemometrical records to be trustworthy and of value, not only must the instrument be exposed in an open place, free from local obstructions, but it is also absolutely essential that the stand which carries it shall offer practically no resistance to the wind, and that the instrument should not be placed on the roof of a house. The paper was illustrated by a number of lantern slides.—An interesting collection of photographs of clouds, sent to the Society by Mr. H. C. Russell, F.R.S., of the Sydney Observatory, was also exhibited.

CAMBRIDGE.

Philosophical Society, April 27.—Prof. J. J. Thomson, President, in the chair.—On photographing the whole length of a spectrum at once, by Prof. Liveing. Prof. Liveing exhibited photographs of a variety of spectra in which the whole length of the spectrum between the wave-lengths 550 and 214 was depicted on a celluloid film at one operation. A concave grating of $10\frac{1}{2}$ feet radius was used, with the slit in the centre of curvature, and the slide which held the sensitive film formed part of a cylinder with a radius of $5\frac{1}{4}$ feet, so that, when the axis of this cylinder was midway between the slit and grating, every part of the spectrum was perfectly focused on the film.—On dioxymaleic acid and its derivatives, by Mr. Fenton. This paper contains a brief summary of the author's recent work upon oxidation products of tartaric acid.—(*a*) On the atomic weight of oxygen; (*b*) on the combining volumes of carbon monoxide and oxygen, by Mr. A. Scott. Mr. Scott gave a short account of the present state of our knowledge as to the atomic weight of oxygen, and said that it might be regarded as conclusively proved that if $H = 1$, $O = 15{\cdot}87$ to $15{\cdot}88$. Morley determined the densities of hydrogen and of oxygen, the ratios by volume in which the gases combine (by a somewhat indirect method), and finally combined known weights of hydrogen and weighed the water produced. Thomsen made similar determinations, but with far less pretension to the highest accuracy attainable. The results were:

		Morley.		Thomsen.
Weight of a litre of oxygen at 0° C. and 760 mm. at sea-level, lat. 45°.	...	1·42900	...	1·42906
Ditto for hydrogen	...	·089873	...	·089947
Ratio of densities	...	15·9002	...	15·8878
Ratio of combining volumes	...	1 : 2·00269	...	1 : 2·00237
Atomic weight of oxygen	...	15·879	...	15·869

The ratios by volume in which the gases combine agree well with that published by the author directly three years ago, viz. 1 : 2·00245 at about 15° C., and 1 : 2·00285 at 0° C. Mr. Scott also described some preliminary experiments made to determine the ratio by volume in which carbon monoxide and oxygen unite to form carbon dioxide and to determine at the same time the volume of the latter gas in terms of the others. Experiments so far showed that the ratio was very nearly 2 : 1 for the combining gases, but that satisfactory determinations of the volume of carbon dioxide produced had not been obtained as yet.—On the active principles of Indian hemp, by Messrs. Wood and Easterfield. The authors have examined a sample of charas, the exuded resin of Indian hemp, with a view to isolating the physiologically active constituent. They find that charas contains a compound $C_{18}H_{24}O_2$, B.P. 265°–270° C. at 15 mm. pressure (31 per cent.), to which they attribute the physiological action of the hemp plant. This active compound, which the authors name *Cannabinol*, is a red semi-solid substance at ordinary temperature, but is quite liquid at 60° C.; it yields a monacetyl and monobenzoyl derivative, and can be nitrated. The same compound has been isolated by the authors from the usual medicinal preparations of *Cannabis indica*.—Note on the pharmacological action of hemp resin, by Mr. Marshall. The pharmacologically active compound of charas is the compound, cannabinol. In doses of 0·1 g. to 0·15 g. it produces decided intoxication characterised by fits of uncontrollable laughter, slurring speech, and ataxic gait, a complete loss of time relation, and a sense of extreme happiness: sensation is diminished somewhat, and the pulse-rate rises: as a rule, there are no hallucinations. The acute symptoms last about three hours Smaller doses (0·05 g.) produce similar effects, but to less marked degree. Animals appear to be less susceptible to its influence than man, and herbivorous animals than carnivorous.

PARIS.

Academy of Sciences, May 18.—M. A. Cornu in the chair.—Second note on the theory of gases, by M. J. Bertrand. A critical analysis of Maxwell's second demonstration of the formula giving the distribution of the velocities between the molecules of a gas.—On the *rôle* of the ring of iron in dynamo-electric machines, by M. A. Potier. Remarks on a note by M. Marcel Deprez. The experiment quoted by M. Deprez is only in apparent contradiction to the ordinary rule, the principles involved having been already utilised in the construction of dynamos.—Emission of new radiations by metallic uranium, by M. Henri Becquerel. Metallic uranium gives off invisible rays possessing properties similar to the salts of that metal previously

studied.—Preparation and properties of uranium, by M. H. Moissan.—The significance of an axis of symmetry in plants, by M. A. Chatin.—On the transformation of fat into carbohydrate in unfed animals, by M. A. Chauveau. During hibernation it has been noticed that the animal may increase in weight. This can be accounted for by the partial oxidation of the stearin to glucose, carbon dioxide, and water. If this is really the case the respiratory constant should be about 0·27.—On the integration of the differential equation of the radius vector of a certain group of small planets, by M. O. Backlund.—On a family of left-handed curves, by M. Jules Andrade.—The area of parabolas of higher order, by M. P. H. Schoute.—On some properties of the X-rays penetrating ponderable media, by M. C. Maltézos. A mathematical proof that if the X-rays be regarded as hyper-ultra-violet rays, the different absorptive power of various substances may be explained by supposing that the index of refraction is not exactly unity, but a number very near this value, and depending on the density.—On the application of the formula of Clapyron to the melting point of benzene, by M. R. Demerliac. An experimental study of the lowering of the melting point of benzene by pressure. The manometer used had been calibrated against a mercury column directly, and the alterations in temperature were measured to ·001° by the changes in resistance of an iron wire forming an arm of a Wheatstone's bridge. The alteration in melting point for an additional pressure of one atmosphere calculated from Clapyron's formula is 0°·02936; the experimental figure is ·0294, the difference being less than the errors of observation.—Remarks on the reply of MM. Benoist and Hurmuzescu, by M. Aug. Righi.—Observations on the X-rays, by M. T. Argyropoulos.—On a new ozone generator, by M. G. Seguy.—On a new apparatus for electrolysis, by M. D. Tommasi. In the apparatus described the advantages claimed are the suppression of polarisation, that the deposited metal is removed from the oxidising action of the bath, and that the electrical resistance of the bath is considerably reduced.—Researches on nickel cyanide, by M. Raoul Varet. A thermochemical study of nickel cyanide and its double salts. The thermal data show that the compounds undissociable by dialysis, may be looked upon as salts of a complex acid, hydronickelocyanic acid, differing only from ferrocyanides in stability.—On a crystallised tetrachromite of barium, by M. E. Dufau.—On the chloraloses, by M. Hanriot. Galactose forms a compound with chloral similar to the chloraloses previously prepared. The acetyl and benzoyl derivatives and the acid obtained on oxidising with potassium permanganate are described. The corresponding reactions with levulose were also examined.—On some aromatic symmetrical derivatives of urea, by MM. P. Cazeneuve and Moreau. Carbonate of guiacol serves as the starting point for these compounds, aniline giving diphenyl-urea, paratoluidine, di-paratolyl-urea, and ortho-toluidine, diorthotolyl-urea.—On the ratios which exist between the chemical constitution of organic compounds and their oxidisability under the influence of laccase, by M. G. Bertrand. The degree of oxidation of the aromatic polyphenols studied appears to depend upon the facility with which they can be transformed into quinones.—Characterisation and separation of the chief vegetable acids, by M. L. Lindet. For the separation of citric and malic acids advantage is taken of the different solubility in methyl alcohol of their acid quinine and cinchonine salts.—On the internal appendages of the female genital organs of the Orthoptera, by M. A. Fenard.—On the general relation connecting the degrees of sensation and luminous intensity, and on the laws of simultaneous contrast of lights and tints, by M. C. Henry.—On the browning of the cuttings of the vine, by MM. P. Viala and L. Ravaz—Researches on the carpellary venation in the bicarpellary Gamopetalæ of Bentham and Hooker, by M. Paul Grélot.—On the siphons of springs and underground rivers, by M. E. A. Martel.—The *Cadurcotherium*, by M. Marcellin Boule.—Measurements of the variation in length of glaciers in the French region, by Prince Roland Bonaparte.—Method for defining the position of the surface of emission of the X-rays, by M. Stcherbakof.

BERLIN.

Meteorological Society, April 14.—Prof. Bornstein, President, in the chair.—Dr. Schwalbe spoke on the investigation and most important theories of atmospheric electricity, and added an account of experiments he had made on the dissipation of electricity by vapour. A metal plate insulated, charged to ten volts, and connected with a Thomson's quadrant electrometer, discharged itself in exactly the same time when dry as when wetted with water or other easily vaporised fluid. Sprinkling with finely pulverised quartz greatly hastened the discharge; coarsely powdered glass to a less extent. The time of discharge was the same for a rough as for a polished plate. He considered that these experiments had settled the fact that vapour does not discharge an electrified body, but that fine powders do.

Physical Society, April 17.—Prof. Warburg, President, in the chair.—Prof. König spoke on the number of visual units existing in the human retina. The acuteness of vision was measured by the distance at which a grating made of regular rectilinear wires begins to appear wavy. Starting at the *fovea* it diminishes towards the periphery, and in such a way that the curves of equal visual acuteness form concentric ellipses. The area of each retinal field by which two wires are seen as two, increases towards the periphery. If such a field be called a visual unit, then their total number for the whole retina is 50,000. If it be assumed that each unit can perceive three kinds of colour, of which the resulting impulse is conveyed to the brain by a separate nerve fibre, then there must be 150,000 fibres in the optic nerve. As a matter of fact, histologists give them as 400,000 to 500,000 in number. He further discussed the experiments he had made in conjunction with Dr. Zumpf, which had shown that objects of different colour must be perceived at different depths in the retina. The difference of these depths for red and blue rays was found to be so great, that one lay in the pigment layer, which must hence be regarded as a sensory organ. As a matter of fact, quite recently an English anatomist has described the existence of spherules in this layer united to a nerve-plexus from the rods and cones. He finally gave an historical retrospect of Purkinje's phenomenon, in which two coloured (red and blue) fields of equal luminosity as seen by daylight appear unequally luminous at twilight, the red disappearing much sooner than the blue. After this phenomenon had been studied by a whole series of observers, and its importance insisted upon, Prof. Hering had quite recently found that it is really an exceptional phenomenon. It can only be observed in dark surroundings; in daylight and bright surroundings the differently coloured fields remain equally luminous, while the intensity of their illumination is reduced down to a point at which colour perception ceases. Prof. König had satisfied himself of the truth of the above observation, so that Purkinje's phenomenon has now lost all its supposed significance.

May 1.—Prof. von Bezold in the chair.—Dr. du Bois spoke on the magnetising and hysteresis of various kinds of steel and iron, basing his remarks on experiments made in conjunction with Mr. E. T. Jones. The discrimination of different samples of iron by means of their hardness has now lost all its importance; the real criterion is rather hysteresis, coercitive power, residual and maximal magnetisation, which had been determined, together with other magnetic properties, for a large series of samples. Chemical composition is of less importance than the mode of treatment during manufacture from ore to metal. The magnetic constants of the material are of importance to physicists and technologists. The speaker then gave the results of his measurements for three kinds of iron with maximal, and three with minimal hysteresis. As a general rule hardening increases hysteresis and coercitive intensity, whereas residual magnetism is lessened. Krupp's cast-iron is distinguished by its low hysteresis and small coercitive intensity.

PHILADELPHIA.

Academy of Natural Sciences, April 14.—In connection with the presentation of a collection of recent and fossil Strombidæ, Mr. H. A. Pilsbury discussed the ancestry of *Strombus costata* and *Melongena subcoronata*, their relations fossil species being illustrated by large suites of intermediate forms.—Mr. James Willcox commented on the influence of environment on the species as illustrated by the specimens presented. It was apparent that those from the southern coasts of Florida swept by the Gulf Stream were all of a dwarfed type.—Dr. Benjamin Sharp related the plentiful occurence of a Ctenophore, *Mneopsis Leidyi* in a fresh-water pond near Nantucket. The embryos had been swept in by an accession of salt water, and had accustomed themselves to their new environment. The species did not, however, persist in the pond, in consequence probably of the severity of the winter. Specimens of the species referred to were beautifully preserved in a 2 per cent. solution of formaline.—Mr. Pilsbury announced the finding by Mr.

Charles Johnson, for the first time in the Eocence of Texas, of a representative of the genus Scalpellum. It is a new species for which the name Chamberlaini was proposed, in recognition of the services of the Rev. L. T. Chamberlain to palæontological science.

NEW SOUTH WALES.

Linnean Society, March 25.—The President, Mr. Henry Deane, in the chair.—The President delivered the annual address, in the course of which the subject of forestry, especially in relation to the needs and resources of Australia, was brought forward, and the experiments of other countries were summarised, as a safe guide to be followed. The question of the origin of the Australian flora was also dealt with at some length, critical objections being offered to Ettingshausen's views on the characters of the Australian Tertiary flora, based upon no more satisfactory evidence than is afforded by leaf-remains. The address concluded with a summary of the salient points of interest in the recently issued first instalment of the "Report of the Horn Expedition to Central Australia" (Zoology, part ii., edited by Prof. Baldwin Spencer), a work which, in its completed form, promises to be the most comprehensive and elaborate account of the natural history of any portion of the continent ever issued in a self-contained form.—The following papers were read:—A contribution to the structure and relations of the organ of Jacobson in the horse, by Dr. R. Broom.—Descriptions of further highly ornate boomerangs from New South Wales and Queensland, by R. E. Etheridge, jun.—Note on the occurrence of callosities in *Cypræa* other than *C. bicallosa* and *C. rhinocerus*: and on the presence of a sulcus in *Trivia australis*, by Agnes F. Kenyon.—On a new genus and species of Australian fishes, by J. D. Ogilby. The genus *Apogonops* is proposed for a small fish of puzzling affinities from Maroubra Bay. At a first glance it would seem to be naturally referable to the family *Apogonidæ*. But this view is precluded by the absence of vomerine teeth and the number of its dorsal spines, unless it is to be considered as an aberrant Apogonid with sciænoid affinities.—Catalogue of the described Coleoptera of Australia. Supplement. Part ii. *Dytiscidæ* and *Staphylinidæ*, by George Masters.

GÖTTINGEN.

Royal Academy of Sciences.—The *Nachrichten* (mathematico-physical series) part 1 for 1896 contains the following memoirs contributed to the Society.

January 11.—Pendulum observations at Freden and Alfeld, by A. von Koenen.—The movement of the spinning-top, by F. Klein.

January 25.—Discovery of *Ceratites nodosus aut.* in the Vicentine Trias, and its stratigraphical significance. A new demonstration of Kronecker's fundamental theorem on Abelian *Zahlenkörper*. A letter of Gauss to Gerling (on Bolyai's geometry), by Paul Stäckel. Continuous groups of quadratic transformations of the plane, by G. Bohlmann.—On the representation of finite groups by means of Cayley's colour-diagrams.

February 8.—Researches conducted in the Göttingen University laboratory (III.), by O. Wallach. (1) A new heptylamine. (2) Ketones from propenyl-compounds. (3) On reuniol. (4) On pinol hydrate. (5) On isothujone and thujamenthone. (6) Refractive and dispersive powers of a series of isomeric camphors.

March 7.—The theory of the formation of petroleum, by Fr. Heusler.—On a theorem in the analysis of position, by A. Schoenflies.

AMSTERDAM.

Royal Academy of Sciences, April 18.—Prof. Van de Sande Bakhuyzen in the chair.—On four-dimensional prismoids, by Prof. Schoute.—On the equilibrium of radiation in the case of doubly-refracting bodies, by Prof. Lorentz.—Prof. Kamerlingh Onnes presented a paper to be published in the report of of the meeting, and entitled "a contrivance for lighting up scales for mirror-reading," and also, on behalf of Dr. L. H. Siertsema, a communication on measurements of the magnetic rotation of gases. This communication is a continuation of those published in the *Transactions*, 1893–94, p. 31, and 1894–95, p. 230. After supplementing the descriptions of the apparatus, the method of observation, and the manner of calculation—a plate being added for illustration—the author communicated the results with respect to air, oxygen, nitrogen, carbonic acid, and nitrogen monoxide. The results for the first two gases have been deduced from the same observations as the previous ones, but have been re-calculated, a better determination of certain constants having been obtained. Moreover, the rotations have been expressed in minutes, by means of a provisional reduction factor. The results for CO_2 and N_2O must only be considered as provisional, as the pressure was not measured with sufficient accuracy.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—The Alternate Current Transformer: Dr. J. A. Fleming, Vol. 1, new edition (*Electrician* Company).—Physics for Students of Medicine: Dr. A. Daniell (Macmillan).—The Flora of Dumfriesshire: G. F. Scott-Elliot (Dumfries, Maxwell).—Through Jungle and Desert: W. A. Chanler (Macmillan).—The Frog: Prof. A. Milnes Marshall, 6th edition, edited by Dr. G. H. Fowler (Nutt).—The Great Rift Valley: Dr. J. W. Gregory (Murray).—A Manual of North American Birds: R. Ridgway, 2nd edition (Lippincott).—Fur and Feather Series. The Hare: Macpherson, &c. (Longmans)—Press-Working of Metals: O. Smith (Chapman).—Mars: P. Lowell (Longmans).—How Plants Live and Work: E. Hughes-Gibb (Griffin).—Official Year-Book of the Scientific and Learned Societies of Great Britain and Ireland, 13th annual issue (Griffin).—Reminiscences of a Yorkshire Naturalist: Prof. W. C. Williamson (Redway).—Miscellaneous Papers: Prof. H. Hertz, translated by D. E. Jones and G. A. Schott (Macmillan).—A System of Medicine: edited by Prof. T. C. Allbutt, Vol. 1 (Macmillan).—Catalogue of the Madreporarian Corals in the British Museum (Natural History), Vol. 2: H. M. Bernard (London).—Catalogue of the Snakes in the British Museum (Natural History), Vol. 3: G. A. Boulenger (London).—Lehrbuch der Ökologischen Pflanzengeographie: Dr. E Warming, Deutsche vom Verfasser Genehmigte Durchgeschene und Vermehrte ausgabe: Dr. E. Knoblauch (Berlin, G. Borntraeger).—The Indian Calendar: R. Sewell and S. B. Dikshit (Sonnenschein).—Results of Rain, River, and Evaporation Observations made in New South Wales, 1894 (Sydney).

PAMPHLETS.—Die Grenzen Geistiger Gesundheit und Krankheit: Dr. P. Flechsig (Leipzig, Veit).—Thoughts on Evolution: P. G. F. (Sonnenschein).

SERIALS.—Quarterly Journal of Microscopical Science, May (Churchill).—Bulletins de la Société D'Anthropologie de Paris, 1895, No. 6 (Paris, Masson).—Mémoires de la Société D'Anthropologie de Paris, tome 1, 3e série, 4e Fasc. (Paris, Masson)—Journal of the Institution of Electrical Engineers, May (Spon).—Quarterly Journal of the Geological Society, May (Longmans).—Natural Science, June (Rait).—Longman's Magazine, June (Longmans).—Himmel und Erde, May (Berlin).—Illustrations of the Zoology of H.M. Indian Marine Surveying Steamer *Investigator*, 5 parts (Calcutta).—Good Words, June (Isbister).—Sunday Magazine, June (Isbister).

CONTENTS.

THURSDAY, JUNE 4, 1896.

TWO BOOKS ON ELECTRICITY AND MAGNETISM.

Elements of the Mathematical Theory of Electricity and Magnetism. By J. J. Thomson, M.A., F.R.S., Fellow of Trinity College, Cambridge, and Cavendish Professor of Experimental Physics in the University of Cambridge. Pp. vi + 510. (The Cambridge University Press, 1895.)

Elementary Treatise on Electricity and Magnetism, founded on Joubert's "Traité Élémentaire d'Électricité." By G. C. Foster, F.R.S., Quain Professor of Physics in University College, London; and E. Atkinson, Ph.D., formerly Professor of Experimental Science in the Staff College. Pp. xix + 552. (London: Longmans, Green, and Co., 1896.)

PROF. THOMSON'S book will do good in many ways. Even its title will correct a wrong impression which very generally prevails, to the effect that just so much of the fundamentals and facts of the subject as can be discussed with the aid of a smattering of geometry and algebra, constitutes the truly elementary theory of electricity. On the contrary, students will find that the phrase *Elements of Electricity and Magnetism* really means that satisfactory grounding in essential ideas and their relations which is only possible to a student whose mathematical education has been or is being made adequate to the study of the higher parts of electricity. No important part of the subject is omitted, and of course this brings into play here and there mathematical processes more recondite than some which many practical men seem to shrink from. But there is no obtrusion of purely mathematical discussion; the analysis arises just where it is wanted, to the extent to which it is wanted, and goes no further.

A feature of the book which strikes the reader at once is the use made of the idea of Faraday tubes of force, or rather of electric induction in a dielectric. The distribution of these in the field in different cases of electrification is very fully described and illustrated graphically. This is a matter of very great importance. The examination of students supposed to have received a sound training in elementary electricity has convinced us that very few have a really clear notion of the actual nature of the electrification of a conductor in presence of external and internal charges. Of the dependence on the internal system of charges of the amount and distribution of the charge on the interior surface, and of the nature of the effect of the external system on the distribution on the exterior surface, they seem frequently to have no notion whatever, though they talk glibly about Faraday's ice-pail experiment and his "living" within the large tin-foil covered cube he made and electrified.

A very good elementary account is given of the subject of electric images, and several important particular cases are discussed; for example, that of two unequal spheres intersecting at right angles. This is then converted into the useful problem of the effect of a small hemispherical boss on the capacity of a large sphere.

The effect of dielectrics in the field is then considered the method of electrical inversion introduced, and the usual problems of mutually influencing spherical surfaces solved. An excellent characteristic of this part of the book, as indeed of the work as a whole, is the working out of clearly formulated expressions which, on insertion of the proper numerical data, give at once the absolute values of important electrical quantities.

What we have said as to the clearness of the discussion of electrostatic theory applies also to the treatment of magnetism and the steady flow of electric currents. The treatment of electrolysis strikes one as rather meagre, but all the statements made are concise and to the point. The table of electrochemical equivalents on p. 282 stands in need of revision, the decimal point seems misplaced in one or two of the numbers.

In the discussion of the magnetic action of currents, Prof. Thomson applies elementary methods successfully to the determination of the magnetic fields of simple systems of currents, and might possibly have gone further in the same direction. But this chapter, the long one which follows on electromagnetic induction, and the thirteenth, which treats of dielectric currents and the electromagnetic theory of light, are the most interesting and important in the book. The first two of these deal with the phenomena and their quantitative expression, the last discusses the production of a magnetic field by the motion of Faraday tubes, Maxwell's theory of the propagation of electromagnetic disturbances, and the verification of this theory by experiment. To show the extent and thoroughness of the discussion, we may mention that the concentration of a rapidly alternating current near the surface of a conductor is explained by general considerations derived from the flow of heat, and, what is still better, is illustrated quantitatively by the case, which is fully worked out, of alternating currents induced in an infinite mass of conducting material bounded by a single plane face, beyond which in the insulating medium the inducing system is situated. This leads to a comparison of the distances to which currents sensibly penetrate in different metals, such as copper and iron, which lie widely apart as regards magnetic permeability.

An account, necessarily of course very short, but good so far it goes, is also given in the chapter on the "Dimensions of Electrical Quantities," of the absolute determination of resistance and the comparison of units. The method of the revolving coil and that of Lorenz are all that are described in the former case, and Maxwell's bridge method (employed so successfully by Prof. Thomson himself in conjunction with Mr. Searle) of finding in electromagnetic units the capacity of a condenser, and thus finding a number for comparison with the electrostatic value, is alone given in the latter case.

Here as elsewhere the author does not shrink from the introduction of a differential equation and its solution. The only alternative is the insertion of the result without proof. The inclusion of the necessary analysis, if it can be done without undue prolixity, is not, as it frequently seems to be regarded, an introduction of "useless mathematics." The justification of the result ought always to be indicated. If the reader cannot understand the proof, he can pass it over; its presence may serve to remind him that besides the mere results there is something

more to be apprehended and appreciated—the theory by which they have been obtained.

In the chapter on the "Dimensions of Electrical Quantities," the author introduces besides μ and K a third constant p, which may arise in connection with the relation between the current and the magnetic intensity at any point in the field produced, so that 4π times the current flowing through a closed path in a magnetic field is equal to p times the work done in carrying a unit pole once round the path. The dimensions of this constant are of course unknown, and it is only by assuming its dimensions to be zero that the ordinary dimensions of current in electromagnetic units are obtained. There does not seem any distinctly physical ground for bringing in this constant p. The work done in carrying a pole in a complete circuit round a current is independent of the nature of the medium, and hence, justifiably so far as we can see, it may be taken as unity, without involving any neglect of the physical properties of the medium.

The method of the motion of Faraday tubes of electric induction is used in the chapter on "Dielectric Currents and the Electromagnetic Theory of Light." Perhaps it is possible to make too much of this conception; but there can be no question of its great utility as a means of keeping before the mind of the reader the idea of electric and magnetic action as taking place in the medium, and visualising, as it were, what takes place when a condenser is joined to another and partially discharged, when a current flows in a circuit, and the flux of energy in the medium which accompanies all such changes, whether constant or rapidly variable.

The commendation which the work of Prof. J. J. Thomson thoroughly deserves is the due also of that which Prof. Carey Foster and Dr. Atkinson have based on the elementary treatise of M. Joubert. This work has been recast so as to bring it thoroughly into accordance with the later views of electrical theory, and there can be no question of the entire success with which the English authors have performed their task. The book is a thoroughly sound and practical treatise. In it too, though not to the same extent, for its aim is different in some degree, there is a good deal of fairly advanced theory, and like the former work, it shows no shirking or glossing over of difficulties. It contains a more detailed account of the experimental details of the subject than the other work, and this, by the use of a somewhat small but still perfectly clear type, is got in without unduly swelling the volume. The two books read together would form an excellent combination. They are enough to give any competent student a most desirable acquaintance with the essential parts of the main phenomena, and their elementary theory. Such a student would afterwards go easily and rapidly forward with the study of the more elaborate theoretical works, and of the researches which have lately advanced electricity so much—the absolute determinations of electrical constants which have been made by so many experimenters, and the improved science of electrical measurement which these, together with the experimental investigation of the electromagnetic theory of light, and the vast development of practical electricity, have brought into existence.

A. GRAY.

ANNALS OF THE CALCUTTA BOTANIC GARDEN.

Annals of the Royal Botanic Garden, Calcutta. Vol. v. Part I. Pp. 9 + 68, 101 plates. (Calcutta: the Bengal Secretariat Press, 1895.

THE Royal Botanic Garden, Calcutta, has been publishing from time to time a series of "Annals," illustrative of the flora of the continent of India, the adjacent islands, and the contiguous countries. Volume v. of this work was published last year, and Part 1 consists of "A Century of Indian Orchids" by the chief of contemporary botanists, Sir Joseph Hooker. The Calcutta Garden has had the advantage of the services and labours of a long series of eminent botanists. Volume v. of the "Annals" is dedicated to perhaps the most distinguished of them, Roxburgh, superintendent from 1793 to 1814, and author of the "Plants of the Coromandel," the "Hortus Bengalensis," and the "Flora Indica," of whom a portrait and a brief memoir are prefixed. It may be well to recall the names of Roxburgh's successors to show how well botany has been served in connection with these gardens. They have been Wallich, Falconer, Thomson, Anderson, Clarke, and King; the last named, an admirable administrator and a distinguished botanist, being still in charge.

Since Roxburgh's time, that is for more than a century, what Sir Joseph Hooker describes as a "magnificent series of Indian plant-portraits by native artists" has been accumulating in the Calcutta Botanic Garden, of which about a thousand are those of orchids.

"The most important of these collections," says Sir Joseph ("Flora of British India," vol. v. p. 176) "were Malayan, abounding in novelties from Penang, Perak, Singapore and Malacca, made by the late Father Scortechini, . . . by Kunstler (a collector sent from the Calcutta Botanical Gardens by Dr. King), by Curtis Hullett, Wray and Ridley. Important collections were also sent by Mann from Assam, Bhotan, and the Khasia Hills; by Gamble from various parts of India; by Duthie from Garwhal; by Clarke from Sikkim, the Khasia Hills, and Bengal, together with a few from Central India; and by Dr. Trimen from Ceylon."

So little accessible were these drawings, and so little was their value known, that it was not until Sir Joseph Hooker had almost completed, as he mentions in his brief preface to the "Century," the descriptions of Indian orchids for his monumental work, the "Flora of British India," that he obtained, through Dr. King, the loan of the native drawings referred to. Sir Joseph further states that "the inspection of these drawings," coupled with the study of other material received from Calcutta, "necessitated a revision of the characters of the greater portion of the species already described, . . . together with the addition of not a few new species."

With reference to these drawings, the author states that, excellent as they are in many respects, they betray "that tendency to enlarge, which is the besetting sin of Indian botanical artists." Perhaps it is rather the indifference to exact accuracy—a strongly-marked characteristic of all Indian artists—which is in fault. No one who has had to do with Indian workmen can have failed to notice how difficult it is to induce them to recognise the importance of accurate measurements and proportions.

Now that so much attention is devoted to orchids in the gardens of Great Britain, and that their cultivation is, comparatively speaking, well understood, the publication of such a volume as the "Century" by our great botanist is a valuable help, not only to botanists, but to gardeners. Although all accessible parts of India have been searched through and through by experienced collectors, it is nevertheless a fact that comparatively few of the plants comprised in the "Century" are known to be in cultivation. Take, for example, the beautiful genus *Dendrobium*, of which so many charming species adorn orchid houses. Eighteen species of the genus are figured and described in the "Century," of which but one is to be found in Veitch's "Manual of Orchidaceous Plants," the best and most complete book on the subject. Even in the recently published "Hand-List of Orchids cultivated in the Royal Gardens" at Kew, there are mentioned but four out of the eighteen. There is an unfortunate tendency among orchid growers to view with scant favour the vast number of beautiful, delicate and interesting *small* orchids. An examination of the plates in the "Century"—which, by the by, are somewhat coarsely coloured—must prove that there are numerous genera and species well worth care and cultivation, even though they may not be as showy as a *Cattleya* or an *Odontoglossum*

Among the more striking of the plants figured in the "Century" are *Dendrobium crocatum* (Hook. f.), with its brilliant orange-coloured flowers; *D. Williamsoni* (Reichb. f.); *D. leonis* (Reichb. f.), with its remarkable imbricated leaves, and exquisite scent of vanille; *Cirrhopetalum gamosepalum* (Griff.); *C. refractum* (Zoll; and *Eria obesa* (Lindl.), with its clusters of spindle-shaped bulbs. Among others the following would be valuable additions to collections from a horticultural point of view—viz. *Acanthephippium striatum* (Lindl.); *Phaius Mishmeensis* (Reichb. f.); *Calanthe herbacea* (Lindl.), a very handsome plant growing in the Sikkim Himalayas, at an altitude of from 4000 to 6000 feet; *Eulophia* (*Cyrtopera*) *nuda* (Lindl.), figured in four varieties, of which the variety *purpurea* is the most distinct; *Eulophia* (*Cyrtopera*) *macrobulbon* (Hook.); *Sarcanthus insectifer* (Reichb. f.), a remarkable and exceptionally bright-coloured species from the Chittagong Hills; and several fine species of the genus *Habenaria*.

As the botanical descriptions in this work are from the pen of Sir Joseph Hooker, it would be presumptuous to praise them. Notes are appended to nearly every description, giving the habitat of the plant, the height above the sea at which it was found, the name of the discoverer where known, and other particulars.

As few of these beautiful and interesting orchids are even mentioned in manuals and lists of cultivated orchids, there is evidently still a wide field for orchid collectors, even in easily accessible parts of the British Empire and the neighbouring countries. And who knows but that the zeal of some collector working in the country north of the Bay of Bengal, might be rewarded at any moment by a re-discovery of that rare gem among slipper orchids, *C. Fairrieanum*! There has been but one importation, in 1857, of this elegant and graceful plant. "Its blossoms," says the late Sir William Hooker, "are certainly among the most exquisitely coloured and pencilled of any in this fine genus." It comes from Assam or Bhotan, countries well within reach; but probably has a very restricted habitat, and a station remote and difficult of access. Still the commercial value of an importation would be so great, that the zeal of importers and collectors ought not to cool until success crowns their efforts. The recent re-discovery of the habitat of the true *Cattleya labiata* (*autumnalis*), found by Swainson in 1818 on the Organ Mountains in Brazil, and lost sight of for over seventy years, is a case in point. May a like happy chance occur in the case of *Cypripedium Fairrieanum*! T. L.

OUR MINERAL INDUSTRIES.

First Annual General Report upon the Mineral Industry of the United Kingdom of Great Britain and Ireland for the year 1894. By C. Le Neve Foster, D.Sc., F.R.S. Pp. 144. Seventeen plates. (London: Printed for Her Majesty's Stationery Office, 1895.)

EVER since the year 1853 the position of the mineral industries of this country has been regularly recorded in an official volume, issued annually under the title of "Mineral Statistics of the United Kingdom." A series of these annuals, extending over nearly thirty years, was prepared under the direction of the late Mr. Robert Hunt, and issued from the Mining Record Office in Jermyn Street. For several years, however, two sets of returns were published concurrently—one set by Mr. Hunt, whose figures were obtained by the voluntary aid of mine-owners, and another set by the Inspectors of Mines, whose statistics were based upon statutory returns, and, consequently, came to be regarded as more trustworthy. To avoid the inconvenience of such duplication, the work of the Mining Record Office was taken over, in 1882, by the Home Office; and thenceforth there issued annually from this department a statistical volume as well as the ordinary Reports of the several Inspectors of Mines. These two publications have hitherto been the only official sources of information on mining published in this country. But something more was evidently wanted—something rather in the shape of a general year-book of mines and minerals. The publication of a comprehensive report of this character was suggested by the Royal Commission on Mining Royalties, and the suggestion was endorsed by the Departmental Committee on Mining and Mineral Statistics. At the request of the Home Secretary, Prof. Le Neve Foster undertook the preparation of such a report; and, considering the initial difficulties incidental to an undertaking of this kind, he is to be heartily congratulated on the work which he has produced.

After an introductory essay, explanatory of the various laws which regulate the working of minerals in this country, Prof. Foster deals with the statistics of the mining population. It appears that the number of persons employed underground in our mines during the year 1894 was 589,689, whilst those working in connection with surface-operations numbered 149,408; thus giving a total mining population of 739,097. The distribution of the underground workers in the various counties is represented on a coloured map, which shows at a glance that Durham and Glamorgan are the two counties with the

largest number of miners. At the same time it must be remembered that, as the miners are not spread uniformly over any of the counties, the actual density of the mining population can never be accurately shown on such a map.

The total value of the minerals raised in each county is approximately indicated on another coloured map; and there are also maps showing the output, according to counties, of coal, iron-ores, lead-ores, and zinc-ores. The statistical maps and diagrams, which add greatly to the value of the Report, have been prepared mainly, we believe, by Mr. J. B. Jordan, whose experience in dealing with mineral statistics has extended over nearly forty years.

Among the diagrams is one showing graphically the annual output of coal and the quantity exported from 1860 to 1894, whilst a similar diagram shows the iron ore raised and the quantity imported for the same period. The annual production of the ores of copper, lead, tin and zinc, during a like period of thirty-four years, is also illustrated by special diagrams. Perhaps the most interesting of all the diagrammatic schemes are those dealing with accidents in mines. These tabular returns, extending from 1851 to 1894, suggest very melancholy reflections, but still it is matter of satisfaction to note that, on the whole, the miner's lot has been ameliorated. Prof. Foster, referring to a table of death-rates, points out that "mining has immensely improved in safety during the last forty-four years. The mortality from accidents has dropped and goes on dropping. From time to time disastrous explosions have caused a temporary rise, but on the whole there is firm and steady progress in the right direction" (p. 36).

Some two or three years ago a great improvement was effected in the "Mineral Statistics" by the introduction of brief descriptive notices respecting the mode of occurrence of the several minerals referred to in the returns. It is understood that these remarks were from the pen of Prof. Foster, and he has very properly reproduced them in this Report. So far as they go, they are models of concise description; but it is to be hoped that opportunity may be found, in some future work, for their amplification, for at present they rather whet the appetite than afford it full satisfaction.

A comparison of the mineral industries of this country with those of other lands, forming Part vi. of the General Report, must have involved an immense amount of labour, inasmuch as it necessitated the collecting and collating of the mineral statistics of the world. The statistical returns are accompanied by valuable descriptive remarks on the resources of each country; and with such thoroughness has this part of the work been done, that Prof. Foster adds notes in connection with countries, like Arabia, Egypt and Turkey, whence little or no statistical information can be procured. There are necessarily many gaps in the foreign statistics; but steps have been taken to secure fuller returns in future, and the subsequent reports will probably be less imperfect. Prof. Foster has prepared a form, in English and French, asking for specific data, and copies of this form have been issued, through the Colonial and Foreign Offices, to Her Majesty's representatives abroad.

Notwithstanding the care bestowed upon the preparation of the Report, and the evident desire to bring its information up to date, it still necessarily falls short, in some respects, of an ideal report on our mineral industries. The information, for instance, respecting stone obtained from quarries is only meagre; but the Quarries Act of 1894 will enable us in future to have statutory returns from all open workings, more than twenty feet deep. If the aid of a staff of specialists could be secured, the descriptive part of the Report might be advantageously expanded, and a volume produced something like that on the Mineral Resources of the United States, issued annually by the Geological Survey, or like the admirable work started a few years ago in New York by Mr. Rothwell. Even, however, in its present form, Prof. Foster's Report presents us with a record of the mineral industries of our country, far more comprehensive, instructive and accurate than anything which the British miner has hitherto possessed.

OUR BOOK SHELF.

Leerboek der Organische Chemie. By Dr. A. F. Holleman. (Groningen: J. B. Wolters, 1896.)

The author in his preface says that text-books of organic chemistry, used in Holland by students of medicine and pharmacy and by candidates in the faculty of science, contain too much and too little—too many facts and too little theory.

There is no doubt that this criticism of our larger organic text-books is a fair one. Volumes like those of Richter and Bernthsen are distended with an unnecessary number of compounds, whilst they conceal within an occasional paragraph of small print important questions of theory; they are books for reference rather than for study. In the present case the author wisely attempts to minimise the number of compounds, and boldly discusses in full-sized type points of theoretical interest as they present themselves. The influence of the Amsterdam school of chemistry is very apparent in this.

We find accounts of geometrical isomerism, including Hantzsch and Bamberger's latest views on the constitution of diazo-compounds, of the relation between osmotic pressure and the freezing and boiling point of solutions, of Arrhenius' electrolytic dissociation theory and its application to the determination of the strength of acids, of the thermodynamic law, which underlies the conversion of racemates into tartrates, &c., all clearly and concisely given.

There can be little objection to physical-chemical theories entering into the composition of an organic text-book; they are interesting and suggestive. But the author has unfortunately fallen into the error of neglecting the practical side of the subject, of too frequently ignoring the laboratory and the works, of omitting experimental details of important preparations, and of presenting to the student chemical reactions as a series of ingeniously contrived equations.

We do not know, of course, for what type of student the book is intended; but it would be out of the question to put it into the hands of a beginner, or of one who had had no previous training in practical organic chemistry.

J. B. Cohen.

Physics for Students of Medicine. By Alfred Daniell, M.A., LL.B., D.Sc., F.R.S.E. Pp. 469. (London: Macmillan and Co., Ltd., 1896.)

Dr. Daniell's "Principles of Physics" is known to be an excellent systematic treatise on physical science, setting forth fundamental principles in a sound and scientific way. In the volume now under notice the same orderly arrangement is followed as in its larger

forerunner, the result being that the book provides a good general preparatory course, which will give students of medicine a broad and satisfactory view of the principles of physics, and will equip them with very serviceable knowledge. Intended primarily to meet the new regulations of the General Medical Council (which make physics a part of the extended course of professional study), the book contains numerous examples of the application of physical principles to medical science, relating both to instruments and muscular actions. But though medical students will find special interest in some of the examples used to illustrate the subjects described, the information given can readily be understood by all who read with studious mind. Therefore we commend Dr. Daniell's volume to teachers of physics generally, believing that they will find it worthy of adoption. The contents include chapters on units of measurement, motion of bodies, friction, matter, sound, heat, ether-waves, and electricity. All these subjects are treated as thoroughly as is possible in a book of this character.

Physics cannot be learned; it must be experienced. Dr. Daniell recognises this, and points out that his work "is not designed to supersede, but rather to clear the ground for practical teaching and demonstration." It is to be hoped that this practical work will some day form a part of the professional curriculum.

Physical Units. By Magnus Maclean, M.A., D.Sc., F.R.S.E. Pp. 147. (London: Biggs and Co., 1896.)

IT can safely be said that this book will find its way into every laboratory where physical facts are investigated. The tables of results brought together in the volume will be most useful for reference; and as they represent determinations made by foremost workers, trust can be put in them. Additional value is given to the tables by the fact that references are made in most cases to the books and papers from which the data have been obtained.

Two-thirds of the book are devoted to the discussion of physical units and the relations between them, the remaining third being taken up with the tables already mentioned. Students of physics will obtain from the text clear and sound knowledge of their units of measurement, and to more advanced investigators the book will prove a veritable vade-mecum.

Elements of the Theory of Functions. By Dr. H. Durége. Translated by George Egbert Fischer and Isaac J. Schwatt. Pp. 288. (Philadelphia, 1896.)

THE late Prof. Durége's treatise, in this English translation, will be a welcome addition to the works on this subject by Forsyth and Harkness and Morley. Durége has a genial method of exposition, as all who know his other book on Elliptic Functions will testify. The numerous definitions and novel ideas in the "Theory of Functions" are made clear by well-chosen illustrations and diagrams. There is no reference to the date of the first edition, but we believe it goes back some thirty years; so that Durége could claim to be a pioneer in the presentation of this subject to the general reader, Weierstrass's ideas being inaccessible to all except his own university pupils. G.

Charles Darwin and his Theory. By M. A. Antonovich. Pp. 353, with a portrait. (Russian.) (St. Petersburg, 1896.)

THIS is a very good summary of the chief works of Darwin, in which his scientific views are intimately interwoven with personal details of his life, in so far as they are known from Francis Darwin's "Life and Letters," and partly from Krause's "Charles Darwin," the whole being written with a deep admiration of both Darwin's personal qualities and his philosophy.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Query concerning the Origin of Atolls.

HAVING recently visited and studied in some detail the coral mass of the Bermuda Islands, I have been impressed by one thing more than by anything else, namely, the fact so long known that the islands owe their present elevation almost exclusively to the action of the wind. The hills, which often rise to a height of 200–250 feet above the sea, from near their base to their summit, are made of blown coral sand, now consolidated into a more or less compact rock.

A recent subsidence has carried most of the islands below the sea level, leaving only the more elevated southern part above, because this had been built higher than the rest by the strong southern winds. This subsidence has been so recent that the heavy south waves are still battering at the cliff; and the débris thus obtained, added to that furnished by the abundant coral growth of the reef which lies immediately off shore, has not yet been able to build extensive beaches. Here and there we find beaches, usually small ones, and from these the sand is even now marching inland and adding to the height of the land, illustrating the process by which the islands have been reared to their present height. Nevertheless, although in a few places the importance of the wind action is still illustrated, it is practically at an end, and that because of a recent subsidence of certainly 50 feet and probably less than 100 feet.

On the basis of these facts I wish to propound a query which has arisen in my mind, but which I would not assume to answer on the basis of a study of only one coral island. Granting an atoll ring formed in the mid-ocean in the way which the theory supported by Dr. Murray and others demands, would we not of necessity have first a ring of reef or beach rock, then of coral sand which with age continued to rise in elevation until the Bermuda stage was reached? For various reasons a luxuriant vegetation would not at first serve to check this. A constant supply of sand is furnished by the life which skirts the shore, the waves are present to drive it on the shore, and the wind to heap it up.

Given this tendency and islands either standing at a uniform level, or being elevated, there should, it would seem, be all gradations between the atoll ring and the insular mass of wind-blown sand not unlike the Bermudas. If, however, the older theory advocated by Darwin and by Dana were correct, there would not need to be such a condition, for subsidence would counteract the action of waves and winds, and the ring condition of the low atoll could easily be the type condition.

Cornell University, Ithaca, N. Y. RALPH S. TARR.

"The Primary Factors of Organic Evolution."

IN a review of Prof. Cope's "Primary Factors of Organic Evolution" (NATURE, vol. liii. p. 553), Dr. Alfred R. Wallace denounces its "extraordinary statements," its "misstatements," and its "absurd arguments," and finds it refreshing to turn to the original ideas and acute reasoning of another book. The fact that the first book is by an opponent and the second by a follower of the reviewer, perhaps accounts for, though it does not justify, opinions that depart widely from what will be the judgment of the most competent. A work of unusual originality such as Prof Cope's, is apt to contain much that is open to criticism; but it is no small matter to have brought together, as he has done, the evidence in favour of finding in the environment, in the movements of animals and in consciousness, the efficient factors of organic evolution. The present writer finds the arguments inconclusive, but he does not understand how any one can read the book without admiring the intimate knowledge of facts and the great powers of generalisation which it discloses. Dr. Wallace states that it is "absolutely untrue" that "the variation which has resulted in evolution has not been multifarious or promiscuous, but in definite directions," yet the evidence offered for this proposition—due perhaps more to Prof. Cope than to any other—has within the past few months proved convincing even to Prof. Weismann. Prof. Cope's book and his work should be adequately described and seriously criticised; but Dr. Wallace has done neither. J. MCKEEN CATTELL.

Columbia University, New York, May 9.

Barisal Guns.

IN reference to Sir Edward Fry's letter in NATURE for May 7, a fuller account of the mysterious sounds heard at Jebel Musa, and Jebel Nagus, in the Peninsula of Sinai, will be found in Palmer's "Desert of the Exodus," vol. i. pp. 217, 251. The former, which an Arab legend attributes to a fairy maiden, who fires off a gun one day in every year to give notice of her presence, "are," says the writer, "in all probability caused by masses of rock becoming detached by the action of frost, and rolling with a mighty crash over the precipice" (of 3000 feet) "into the valley below." The sounds at Jebel Nagus, which have also a legend connected with them, are undoubtedly due to the friction of rolling sand. From experiments made by the explorers, the degree of coarseness of the sand, the angle of inclination of the slope, and temperature, seem to be the controlling conditions.

B. W. S.

Hampstead, N.W.

THE SPERM WHALE AND ITS FOOD.

OUR fund of accurate knowledge of the Cetacea being at so low a level, it is to be deplored that trained scientific observers have hitherto had few opportunities for noting under normal conditions the habits of these most interesting animals. And therefore naturalists generally will certainly hail with delight the news of the resolution of the Prince of Monaco to endeavour by all the means at his disposal to make an effective study of that least understood of all the deep sea mammalia—the great sperm whale. An observer like Dr. Scoresby who, while gaining his livelihood by the pursuit of the Greenland whale, lost no opportunity of studying that monster's manners and customs for the benefit of science generally, is still to seek for the world-wide fishery of the cachalot. This may be said without in the least minimising the excellent work done by Surgeons Beale and Bennett, who remain almost the only first-hand authorities we have on the sperm whale. They were not in command, and were consequently at a great disadvantage for making observations; for the whole crew of a whaleship are co-partners in the venture, and the essential business of oil-getting must on no account be hindered, or there is trouble all around. And since their day, unfortunately, British shipowners have had little or no interest in the southern whale fishery, while none who know what a motley crowd constitute the crews of American whalers, will be surprised that no contributions to natural history come from that quarter. I am the more pleased, therefore, that in the course of my career as a seaman, it happened that I was induced some twenty-one years ago to join a whaleship in New Zealand for a long cruise in the Southern and Eastern seas. All the average sailors' usual ignorance of the differing characteristics of different whales was mine; but so interesting did I find the study of these great denizens of the deep sea, under my extended acquaintance with them, that I seized every chance I could obtain to learn whatever I could of them, without any idea at the time of putting the knowledge so gained to any practical use. The first occasion worthy of note here was also my initial encounter with a cachalot. We were cruising the wide stretch of ocean in the South Pacific known as the "Vasquez" grounds, and sighted a small pod of sperm whales, mostly sprightly young cows, under the guardianship of two or three immense bulls. We lowered four boats, and very soon the boat in which I happened to be "fastened" a medium-sized cow, who promptly returned the compliment by rising bodily beneath the boat and ripping the bottom out of it with her hump. Of course our connection with that whale was at once severed, the task of keeping our heads above water, with our boat hardly more than a bundle of loose planks beneath us, being amply sufficient to occupy all our energies until we were rescued. In the meantime the second mate had successfully harpooned and slaughtered another and much larger whale very near to us—so near, in fact, that we weltered in a gory sea lashed into foam by the monster's dying struggles.

Just before she died, we noticed her in the act of vomiting, and several masses of the matter ejected floated all around us. Some of them were exactly like large blocks of blanc-mange of no particular shape, almost white, but in some instances spotted with various colours. Many of the smaller pieces, however, were unmistakably portions of tentacles; lengths bitten or torn off. These it was most easy for me to identify, even under the awkward conditions, having been long familiar with the leaping or flying squid so often picked up on deck during heavy weather, or taken from the stomachs of albacore (*Scomber thynnus*), bonito (*Thynnus pelamys*), or dolphin (*Coryphæna hippuris*). This peculiar sight, although witnessed under such difficulties, made a very definite impression upon me, and as I had always examined the contents of the stomachs of such fish as I caught, so I longed to eviscerate the captured cachalot for a like purpose, although it was evident that she had probably ejected all the food that her maw had contained. Such anatomical pursuits are, however, quite out of the question at sea in a whaleship. Those who would essay the tremendous task of disembowelling a whale while it floats beside the ship, might indeed be rewarded by a find of ambergris worth more than the whole of the blubber and spermaceti, but the chances are not sufficiently inviting to tempt whalemen to undertake such herculean labours in addition to the already heavy toil of "cutting in."

Long afterwards, while cruising in Foveaux Straits, we caught a gigantic cachalot—the largest I think I have ever seen, even in that haunt of monstrous whales. We had an easy capture, for our prize had been previously attacked by some other ship, and in various parts of his body were the *disjecta membra* of seven exploded bomb-lances. Hardly was he fast alongside when one of those furious westerly gales so common on the southern shores of New Zealand sprang up, and it was well indeed for us that we had a good port under our lee. In spite of the load we had to tow, we arrived in Port William early the next morning with our prize all safe, and at once proceeded to cut him in. While engaged in this satisfactory, if filthy, operation, some Maories and half-breeds came off, and civilly asked if they might have the carcase when we had done with it. As it was of no earthly use to us, permission to take it when we cast it adrift was graciously accorded.

By dint of strenuous toil we got to the last joint of the vertebræ by 4 p.m., and, having disjointed it, the mountain of flesh floated majestically away, to be seized immediately by the waiting beach-men, who, with incredible labour, succeeded in landing the carcase near the western horn of the little bay.

That handful of men, six in all, laboured night and day for the best part of a week to get whatever oil was contained in the skeleton, bowels, and fat about the muscles. As we had finished our labour, a grand opportunity presented itself for examining the interior economy of this whale.

The vast cavity of the stomach contained a goodly assortment of cephalopoda in a more or less fragmentary condition; for I should have said that this whale, unlike most, had not ejected his food before his death. Judging from the sizes of the tails and the girth of some of the pieces, I estimated the largest of the squid at not more than six feet long, exclusive of the head. But what struck me as most peculiar was the large quantity of *bony* fish contained in the stomach of this cachalot. Blue and red rock-cod, groper, barracouta, and sea-bream were there—two or three bushels of them. Some were so recent as to be hardly soiled, and none bitten or damaged in any way except by digestive process.

How so vast and comparatively clumsy a creature could

succeed in obtaining such a large supply of active fish is incomprehensible to me, except upon the supposition that in waters like these, where fish abound in such incredible numbers, the cachalot cruises gently about with the great lower mandible hanging down (its normal position). The fish, mistaking the great livid cavernous throat for a cave of another kind, enter therein, to find egress impossible. But this is only a pious opinion of mine, unsupported by evidence other than the presence of fish where none could reasonably expect to find them, except under some such circumstances as I have supposed.

On another occasion we were cruising between Tongatabu (Friendly Islands) and Futuna, or Horn Island. Just before sunset a solitary sperm whale of goodly size was harpooned by us, and immediately sounded to a depth of 500 fathoms. He remained below the surface for about forty minutes, so that when he broke water again it was nearly dark. Of the terrors of that night I might say much, but this is not the place, neither do I think if it were that I could do anything like justice to the subject. Sufficient then to say that his agility and vitality were unequalled by that of any whale that I have met with, and it was well into the small hours of the morning before he gave up the contest. When day dawned we found that his lower jaw was twisted at right angles to his body, the result probably of some terrific conflict in the long ago. The outstanding portion of the jaw was almost covered with limpets of massive appearance, some measuring six inches across the base, and the intervening spaces were filled in with fringing barnacles of great length, giving him the semblance of a hoary beard. This alone was sufficient to endow a creature of such normal ugliness with an uncanny prehistoric sort of look—and there were not wanting members of our crew to exclaim that this was surely Davy Jones himself. But the chief peculiarity about this cachalot, and, indeed, the reason why I mention him here at all, was the extreme hardness and dryness of his blubber. Under ordinary conditions a whale of his size should have yielded at least seventy barrels of oil, but owing, I suppose, to the difficulty he must have had to procure food, it was only with an extraordinary expenditure of labour that we succeeded in extracting from him thirty-two barrels of oil. The opinion of all on board competent to give one was, that being unable to cope with the big squid, owing to the loss of his great weapon, the lower jaw, he had been driven to seek support on such food as he could obtain, and only managed to exist in a state of semi-starvation. Doubtless this accounted for his agility, and his fine drawn body, more like that of one of the Balænoptera than of a cachalot, went far to confirm the idea.

And now I come to the final instance for the present paper, but by no means the least important, at least to my mind, since it has settled several vexed questions for me finally. We were cruising in the Strait of Malacca, between the Nicobars and the Malay Peninsula, and had succeeded in killing a full-sized sperm whale. He had been a tough customer, needing all our energies to cope with him; but a well-directed bomb closed the negotiations just before sunset. As usual, he had ejected the contents of his stomach before dying, and we specially noticed the immense size of some of the masses floating about. By common consent they were about as large as our hatch-house, which measured 6 ft. × 6 ft. × 8 ft. I must very distinctly state that these masses were not square, but irregularly-shaped masses, bitten or torn off in blocks from the body of some gigantic squid.

The whale was secured alongside, and all hands sent below for a good rest prior to commencing to "cut in" at daybreak. I had the watch from eight bells to midnight, and at about 11 p.m. was leaning over the lee rail, idly gazing seawards, where the rising moon was making a broad lane of silvery light upon the smooth, dark waters. Presently there was a commotion in the sea, right in the way of the moon, and I immediately went for the night glasses to ascertain if possible the nature of it. In that neighbourhood there are several active volcanoes, and at first I judged the present disturbance to be one of these, sending up débris from the sea bed. A very short examination satisfied me that the trouble, whatever it might be, was not of volcanic or seismic origin. I called the captain, as in duty bound, but he was indisposed to turn out for anything short of actual danger, so the watch and I had the sight to ourselves. We edged away a little under the light draught of wind, so as to draw nearer to the scene, and presently were able to realise its full significance. A very large sperm whale was engaged in deadly conflict with a monstrous squid, whose far-reaching tentacles enveloped the whale's whole body.

The livid whiteness of those writhing arms, which enlaced the cachalot like a nest of mighty serpents, stood out in bold relief against the black boulder-like head of the aggressor. Presently the whale raised itself half out of water, and we plainly saw the awful-looking head of the gigantic mollusc. At our distance, something under a mile, it appeared about the size of one of our largest oil casks, which held 336 gallons. Like the rest of the calmar visible, it was of a peculiar dead-white, and in it gleamed two eyes of inky-blackness, about a foot in diameter. To describe the wonderful contortions of those two monsters, locked in a deadly embrace, is far beyond my powers, but it was a never-to-be-forgotten sight. The utter absence of all sound, for we were not near enough to hear the turmoil of the troubled sea, was not the least remarkable feature of this titanic encounter. All around the combatants, too, were either smaller whales or immense sharks, who were evidently assisting in the destruction of the great squid, and getting a full share of the feast. As we looked spell-bound we saw the writhings gradually cease, and the encircling tentacles gradually slip off the whale's body, which seemed to float unusually high. At last all was over, and the whole commotion had completely subsided, leaving no trace behind but an intensely strong odour as of a rocky coast at low tide in the full blaze of the sun. Since that night I have never had a doubt either as to the origin of all sea-serpent stories or the authenticity of the old Norse legends of the Kraken; for who could blame a seaman witnessing such a sight, and all unaccustomed to the close observation of whales, for reporting some fearsome monster with horrent mane and floating "many a rood." An interesting account of the French gunboat *Alecto* falling in with a calmar forty feet in length, lying on the surface in the North Atlantic, once fell into my hands. It told how those on board succeeded in getting a hawser passed round the creature, but in heaving it tight the rope cut its way through the soft gelatinous body, which floated away in halves, and gradually sank. I much regret now that I do not remember anything of the name or date of the publication in which this account appeared. In previous communications of my own to the press on the subject of sperm whales and their capture, I have incidentally alluded to these immense molluscs—*vide Land and Water*, September 29, 1894; *Chambers's*, March 24, 1894; *Pall Mall Gazette*, September 7, 1895; *Sheffield Weekly Telegraph*, November 2, 1895; *Good Words*, September 1895—a few of the most recent ones.

In closing these brief notes, owing to exigencies of space, I would like to add that the only place for accurate observations of these animals is at a bay-whaling station, such as the Prince of Monaco visited at Terceira. If he, with the appliances at his command, adheres to his resolve to pursue this great study, we shall soon be in possession of some splendid data. And he, or others on a similar errand, would find the best opportunities in the southern hemisphere, where the number of sperm whales are simply amazing around certain easily accessible spots.

FRANK T. BULLEN.

THE TORNADO.

THE exceptionally disastrous and destructive tornado which occurred at St. Louis, in the State of Missouri, shortly after five in the afternoon of May 27, draws more than ordinary attention to this class of disturbance, and excites, for a time at least, an interest in such phenomena. These disturbances are by no means of uncommon occurrence in the United States, but it is happily not often that a densely populated city falls directly in the track of the full fury of the storm.

Such well-known authorities as Ferrel, Finley, and Hazen have devoted much attention to tornadoes, and it is chiefly to the writings of these that we look for information. Several years ago the United States Signal Service published a report of the character of 600 tornadoes, and this clearly shows that no season of the year is exempt from their occurrence, but their greatest frequency is in the spring and summer, whilst in winter they are seldom experienced. Their occurrence is more common in April, May, June and July, than in any other months of the year. They almost always occur after the hottest part of the day, the hour of greatest frequency being between three and four in the afternoon, and they seldom begin after six in the evening. The centre of the disturbance is almost always formed in the southern or south-eastern segment of an ordinary area of low pressure, and a study of the weather charts, embracing a large area of the United States, shows that they are often several hundred miles from the centre of the parent disturbance. Those familiar with the formation and behaviour of our thunderstorm disturbances in England, will recognise an analogy to the tornado in their origin and motion with respect to the primary disturbance, of which they are mere secondaries. According to Finley, of the 600 tornadoes upon which he reported, the rotary movement of the whirling cloud was invariably from right to left, or the opposite movement of the hands of a watch. Ferrel remarks that this indicates either that the earth's rotation on its axis, as in cyclones, must determine the direction, or that the atmosphere has numerous whirls in this direction. The progressive motion of a tornado is almost always in a north-easterly direction, and here again there is a resemblance to the ordinary track followed by low-pressure areas in middle latitudes. The velocity of progression of the tornado cloud is said to vary from 7 to 100 miles an hour, the average rate being 44 miles. According to Finley the vortex wind velocities of the tornado cloud vary from 100 to 500 miles an hour, as deduced from actual measurements, and velocities of 800 to 1000 miles an hour have been reported. A wind velocity of 500 miles an hour is equal to about 750 lb. on every square foot. The width of the path of destruction, supposed to measure the distance of sensible winds on the sides of the storm's centre, varies from 40 to 10,000 feet, the average being 1085 feet, as deduced by Finley from a discussion of a large number of instances. The length of the tornado's track varies from 300 yards to about 200 miles, the average being 25 miles. The tornado has many features in common with the cyclone, but as experienced in the United States it is essentially different in many points, and in the interests of science it should be kept distinct. The tornado cloud assumes the form of a funnel, the small end drawing near or resting upon the earth, whilst the cloud and the air below it revolve about a central axis with inconceivable rapidity. Tornadoes differ from cyclones mostly in their extent, but both have vertical and gyratory circulations. A cyclone may extend over a circular area of one or two thousand miles in diameter, while a tornado rarely affects sensibly at any one time so great an area as a mile in diameter. In a cyclone the base is so great in comparison with the height, that the whole mass of gyrating air may be regarded as a thin disc, and consequently a large amount of the force is spent in overcoming the frictional resistances at the earth's surface. In a tornado the height is so great in comparison with the base that the gyratory velocity is almost wholly free from friction. The late Prof. Ferrel, who ranks probably higher than any other authority on winds and storms, was of opinion that a cyclone "requires, in addition to the state of unstable equilibrium for saturated air, such a disturbance in the general equality of temperature over a considerable area that there is a central and somewhat circular area of higher or lower temperature, from which arises a vertical, and consequently a gyratory, circulation"; while the tornado "simply depends upon conditions which give rise to very local disturbances merely." Without doubt the conditions which characterise the tornado are also common to such phenomena as waterspouts, cloudbursts, whirlwinds, wind-blasts, and others of a like nature

An excellent descriptive report of the St. Louis catastrophe appeared in the *Daily Telegraph*, and is abridged below. The report shows that the tornado had many features common to such disturbances. The occurrence of "three separate and distinct storms," which subsequently became one, is especially alluded to by Ferrel in his general description of tornadoes. He says: "As the tornado originates in air in the unstable state, it often happens that there is about an equal tendency in the air of the lower stratum to burst up through those above at several places in the same vicinity at the same time. Each of these gives rise to a separate and independent gyration in the atmosphere, and a small funnel where they are of sufficient violence · but generally, as they increase in dimensions and violence they interfere with one another and finally become unite into one." The reported wind velocity of eighty miles an hour appears to be an estimate formed outside of the central area of the storm. In England the wind has attained a velocity of 107 miles for a whole hour, registered at Fleetwood in the gale of December 22, 1894, and at Holyhead on February 20, 1877, the anemometer registered an hourly rate of 200 miles for a short time in the gusts.

The weather at St. Louis nearly the whole of Wednesday, May 27, was unusually warm and oppressive. There was not a breath of wind, and the people suffered greatly from the heat. About four o'clock in the afternoon the western horizon became banked with clouds piled one on top of the other, with curling edges tinged with yellow. The sight was beautiful, but somewhat terrifying. Then a light wind sprang up, followed by sudden and ominous darkness.

The gloom deepened, and when the storm actually burst upon the city pitch darkness prevailed. These strange atmospheric disturbances had created anxiety among the people abroad in the streets, but not alarm.

There seemed to be three separate and distinct storms. They came from the north-west, from the west, and from the south-west, but when these reached the river they had become one.

Before the great mass of menacing clouds which were hanging over the villages of Clayton, Fernridge, Eden, and Central gave forth their contents funnel-shaped formations shot out of them. Some of these funnels seemed to be projected into the air; others leaped to the earth, twisting and turning like some wounded monsters. Lightning played about them. There was, in fact, a marvellous electrical display. Then came the stupendous outburst.

From the great black clouds came a strange, weird, crackling sound, at times stronger than the incessant peals of thunder, which had from the first been a terrifying feature of the storm. The funnels enveloped the western side of the city, and within thirty minutes of their first appearance on the horizon they were dealing out destruction.

So irresistible was the storm in its power, and so much greater in its magnitude than any other previously recorded in America, that some of the staunchest business blocks in St. Louis, considered absolutely tornado-proof, went down before it as though they were mere barns. Iron girders were torn from their massive fastenings and carried blocks distant. Roofs that were braced

and held by every device known to architects and engineers were wrenched off and hurled into the streets. The destruction of telegraph material was phenomenal. The poles were blown down in long rows, not singly, but in groups of a dozen or more at a time.

The western end of the Eads Bridge—admittedly one of the finest in the world—was destroyed. The same fate overtook other splendid bridges spanning the Mississippi.

The scene on the river at the moment the cyclone passed over it was awe-inspiring. The river tossed and boiled as though it was a whirlpool. Great waves struck the vessels and swamped them. Some steamers were blown bodily high up upon the banks, and others were twisted right round. Others, again, after being torn from their moorings disappeared in the torrent and were never more seen. As a rule the smaller craft did not live in the terrible sea for a minute, but just capsized and sank.

In the smaller places through which the tornado passed the terrible funnels rose and fell as they swiftly moved, and thus the line of destruction was not continuous. But whatever stood in their path was either destroyed or badly damaged, and all this destruction was done within the space of one hour.

About five hundred persons are reported to have been killed during the passage of the tornado, and more than seven hundred injured. The path followed is now shown to be a well-defined track about half a mile wide and four miles long.

NOTES.

THE second of the two annual conversaziones of the Royal Society, to which ladies as well as gentlemen are invited, will take place on Wednesday, June 10.

THE University of Paris will be represented at the forthcoming jubilee of Lord Kelvin, by MM. Moissan, Lippmann and Picard. The Royal Astronomical Society has appointed the President, Dr. A. A. Common, F.R.S., as its representative upon that occasion; and the Senate of the University of Sydney have appointed the Chancellor, Sir William Windeyer, and Prof. Liversidge, F.R.S., the Dean of the Faculty of Science, to represent them.

WE have referred from time to time to the approaching eclipse of the sun. During the last week some members of the expedition to Japan have sailed. From information received from the Japanese Minister, the reports of the bad weather chances at the station chosen are more than confirmed. The mean of the last five years gives for August—

	Days
Clear ...	0
Cloudy	22
Rain or snow	22

With regard to the Norwegian parties, Dr. Common will occupy a station at Vadsö, and in his neighbourhood will be Dr. Copeland. Mr. Norman Lockyer intends, if possible, to observe on the south side of Varanger fjord, if a suitable anchorage and observing station can be found sufficiently near the totality line. This point will be inquired into by Captain King Hall, of H.M.S. *Volage*, which will be detached from the Training Squadron for this purpose.

LIEUTENANT PEARY is making arrangements for another trip to Greenland, one of the objects being to bring back for the Philadelphia Academy of Sciences the forty-ton meteorite discovered by him last year, being the largest in the world. He will shortly give an account of his important explorations in Northern Greenland to the Royal Geographical Society.

THE Council of the British Medical Association desire to remind members of the profession engaged in researches for the advancement of medicine and the allied sciences, that they are prepared to receive applications for grants in aid of such research. Applications for sums to be granted at the next annual meeting must be made on or before June 15, in writing, addressed to the General Secretary, at the office of the Association, 429 Strand, W.C.

THE Commissioners of the proposed zoological park of New York City have selected as the site that portion of Bronx Park lying south of Pelham Avenue, comprising two hundred and sixty-one acres. It is expected that their selection will be approved. The site is near the new botanical garden, and New York City will thus acquire in this year ample zoological and botanical gardens and an aquarium.

PROF. N. L. BRITTON has been appointed superintendent of the new botanical garden of New York City.

THE death is announced of M. Raulin, Professor of Industrial and Agricultural Chemistry in the University of Lyons.

THE Paris correspondent of the *Times* announces the death, at the age of eighty-two, of M. Daubrée, the eminent geologist. Born at Metz, and educated at the Polytechnic School, Paris, he was sent on a geological mission to Algeria, and from 1839 to 1855 was a Professor at Strasburg University. He was then promoted to a chair at the School of Mines and the Natural History Museum, Paris. His experimental researches, on the action of rapidly moving and high-pressure gases on rock masses, and the application of the results to peculiar rock formations, are still fresh in the minds of every one interested in geological problems.

WE regret to notice the death of Sir J. Russell Reynolds, F.R.S., on Friday last, at the age of sixty-eight. He was educated at University College, London, where he became Professor of the Principles and Practice of Medicine in 1865. Four years later he was elected a Fellow of the Royal Society. He was President of the British Medical Association in 1895, in which year he also received the honorary LL.D. degree at Aberdeen, and recently a similar honour was conferred upon him by the Edinburgh University. On the death of Sir Andrew Clark, in 1893, he was elected President of the Royal College of Physicians, which post feeble health compelled him reluctantly to relinquish at the recent annual election. Sir Russell Reynolds' works on diseases of the brain and spinal cord are valuable contributions to medical literature, and the "System of Medicine," of which he was the editor, stands as a proof of his sound sense and good judgment.

THE forty-first annual exhibition of the Royal Photographic Society will be held from September 28 to November 12, in the gallery of the Royal Society of Painters in Water Colours. Negatives, transparencies, photo-mechanical prints, stereoscopic work, photographs of purely scientific interest, photographs coloured by scientific or mechanical means, and photographic apparatus will be admitted. Foreign exhibitors are invited to contribute photographs or apparatus. Exhibits must be received by the Secretary of the Royal Photographic Society, on or before September 9.

THE President of the Board of Trade has appointed a Committee, consisting of the following gentlemen, viz.:—Lord Blythswood (chairman), Sir Benjamin Baker, K.C.M.G., F.R.S., Sir J. Lowthian Bell, Bart., F.R.S., Prof. Wyndham Dunstan, F.R.S., Prof. A. B. W. Kennedy, F.R.S., Major F. A. Marindin, R.E., C.M.G., Mr. E. P. Martin, Prof. W. C. Roberts-Austen, C.B., F.R.S., Dr. T. E. Thorpe, F.R.S., Prof. W. C. Unwin, F.R.S., and Mr. E. Windsor Richards—to inquire as to the extent of loss of strength in steel rails produced by their prolonged user on railways under varying conditions, and what steps can be taken to prevent the risk of accidents arising through such loss of strength. Mr. W. F. Marwood, of the Board of Trade, has been appointed to act as Secretary to the Committee.

By the will of the late George Yeoman Heath, Professor of Surgery in the University of Durham, and President of the Durham College of Medicine, a sum of £200 is awarded every second year for a surgical essay. We learn from the *Lancet* that the second award will be given to the writer of the best essay on "Congenital Deformities, their Pathology and Treatment." All graduates in medicine or in surgery of the University of Durham are eligible to compete for this scholarship, and the essay, which must be type-written or printed, should be delivered to the trustees not later than March 31, 1898. The essay, together with any specimens, drawings, casts, microscopical preparations, or other means of illustration accompanying it, will become the property of the College, though by permission the essay may be printed for general circulation by the Heath scholar. This is one of the most valuable surgical prizes in the kingdom, and the competition should be keen.

THE Société helvétique des sciences naturelles will hold its seventy-ninth meeting from August 2 to 5, at Zürich. This will be the sixth occasion on which the Society has met at that place, and it will do so very appropriately in August next, because the Zürich Societé des sciences naturelles—the oldest of those existing in Switzerland—celebrates this year the 150th anniversary of its foundation. A number of papers have already been promised in the various sections into which the congress will be divided. All who desire to be present, or to contribute papers, are requested to communicate with the Secretary, Dr. Aug. Aeppli, Kinkelstrasse, Zürich IV., before July 15. The Swiss Societies of geology, botany, and entomology will meet at the same time as the Société helvétique des naturelles sciences. A geological excursion has been organised, under the direction of Prof. A. Heim, and there will also be a botanical excursion. Every one interested in the advancement and unity of science is cordially invited to attend the meeting.

AT the Electrical Exposition in New York, a few days ago, messages were sent all round the world, and received back in a few minutes. A vast audience hailed with enthusiasm the return of the messages from their long circuits. The first surprise was the announcement that a message had been received within four minutes after sending it, having meanwhile twice crossed the continent of America and the Atlantic Ocean. At London the message was rewritten, and sent on to Tōkiō, and back to New York by a circuitous route, covering 27,500 miles in about fifty minutes. Another message, making another circuit of equal length, returned a few minutes later; while a message sent all round South America, came back in twenty-three minutes. The messages were dictated by Chauncey M. Depew, President of the New York Central and Hudson River Railroad, and Mr. Adams, President of the Niagara Falls Power Company. Mr. Edison received one or two of them. The messages will be preserved in the Smithsonian Institution, together with copies of all papers throughout the world that published them, so far as they can be obtained.

A SLIGHT shock of earthquake is reported to have been felt in West Cornwall, at five minutes to seven on Friday morning, May 29. An earthquake shock also occurred in Dumfriesshire, and a noise resembling a distant peal of thunder was heard. Furniture and crockery were agitated by the movement, which lasted a few seconds, and does not appear to have been attended by any damage of consequence.

IT appears from the annual reports of the six Pasteur Institutes existing in Russia and Poland (St. Petersburg, Moscow, Warsaw, Odessa, Kharkoff, Samara, and Tiflis), that during the year 1892 no less than 2886 persons applied at the Institutes for anti-rabic treatment, as against 2976 in 1891. Out of them, 2763 persons were put under treatment. The percentage of deaths was, as usual, very high for wolves' bites, viz. from 2·22 to 37·5 per cent. in the different institutes; while for dogs' bites the percentage of deaths was insignificant, that is, from 0·5 to 1·05.

AMONG many articles of interest in the May number of the *Essex Naturalist*, is one by Mr. Henry Laver on "Potash Making in Essex: a lost rural industry." In the beginning of this century the preparation of alkali by the lixiviation, in large iron or copper pots, of the ashes of wood, straw, grasses, and other vegetable refuse, was a very common rural industry in Essex, the "pot-ash" thus produced being frequently converted at once into soap. The decay of this industry must be chiefly attributed to the production on the large scale of the cheaper soda-ash from salt, and to the introduction of coal instead of wood as fuel. Mr. Laver contrasts the healthful conditions under which the potash was produced a century ago, with those under which soda is produced at the present day; a contrast much to the disadvantage of the latter.

IN the *Comptes rendus* for May 4, one of Maxwell's early proofs of the "error law" of distribution of velocity in the kinetic theory of gases receives severe criticism in the hands of M. J. Bertrand. In the work referred to, Maxwell claimed to have solved the problem of finding the law of distribution of speed in a system of molecules without making any assumptions as to the nature of these molecules or the forces between them beyond that, on account of the absence of all regular order, everything was distributed equally in all directions. After comparing Maxwell's problem to the favourite schoolboy question, "Given the dimensions of a ship, find the age of its captain?" M. Bertrand points out that the proof in question really involves a very important assumption, and one which he appears to regard as unjustifiable. If x, y, z be the velocity-components of a molecule in three directions at right angles, Maxwell states, or rather *assumes*, that the velocity x has no influence on the velocities y and z, their directions being independent, and hence that the number of molecules whose velocity-components lie between the limits $dx\,dy\,dz$ is represented by an expression of the form

$$N\,\phi(x)\,\phi(y)\,\phi(z)\,dx\,dy\,dz.$$

M. Bertrand considers that the x component *does* influence y and z, and that by neglecting this influence, which is great, Maxwell obtained a solution of an insoluble problem.

THE kinetic theory also forms the subject of an article by Prof. Boltzmann in *Wiedemann's Annalen*, in which he attacks some views recently enunciated by Herr Zermelo. Prof. Boltzmann regards the Boltzmann-Maxwell Law as a theorem in probability, rather than a principle of abstract dynamics. There is nothing to preclude the *possibility* of the molecules of a gas behaving at any instant in a totally different manner from that indicated by the law, but the greater the number of molecules the more improbable does such a departure from the law become.

IN the *Botanical Gazette* for April, an interesting case of mimicry is described, the seeds of the "Philippine island bean" from the coast near Manila, so closely resembling the quartz pebbles among which they fall, in shape, size, colour, lustre, hardness, and stratification, as to be indistinguishable from them except by a very close examination. The size and shape of the beans are both very variable, ranging from 10 to 23 mm.; some perfectly resemble well-rounded beach pebbles, while others mimic pebbles which have been broken across. Their colour varies from moderately dark to light drab, some giving a faint greenish tinge; others resemble pebbles of chalcedony or of crystallised quartz. Nearly all the specimens show a series of approximately parallel darker lines passing round, very suggestive of stratification. All are quite hard, cut only with difficulty

with a knife, and give a clinking sound when shaken together in the hand. They are not affected by soaking in sea-water.

A MONOGRAPH of the *Crambidæ* (or grass moths) of North America, by Dr. C. H. Fernald, was issued by the Massachusetts Agricultural College in January of the present year. Much care seems to have been bestowed upon this essay, which extends to ninety-three pages, and is illustrated by three plates of details, and five coloured plates of quite unusual excellence, as well as occasional woodcuts.

THE interesting address on Meteorological Observatories, delivered by Mr. Richard Inwards before the Royal Meteorological Society, early in this year, is published in the April *Journal* of the Society, with illustrations of the Temple of the Winds, Athens, Greenwich Observatory, and Kew Observatory. Mr. Inwards has brought together a large amount of general information on meteorological observatories in various parts of the world.

THE report of the Marlborough College Natural History Society for 1895 has just been issued, and contains numerous articles, not only on local ornithology, entomology, botany and meteorology, but also on archæology, astronomy and chemistry. There are also illustrations of Wayland Smith's Cave, and of High Street, Marlborough, after the great storm of June 26, 1895. Times seem to have changed since classics and mathematics were regarded as the only subjects worth thinking about at a public school.

BY order of the Government of Madras, that Observatory has published a valuable series of daily, monthly, and yearly meteorological means, as a supplement to the volumes already issued giving the meteorological observations from 1796 to 1890. They are not intended as a discussion of those observations, but have been prepared specially for use in various offices which issue daily weather charts of Indian regions. The rainfall values extend over eighty years, and the barometrical means over fifty years.

WE have received the nineteenth report of the State Entomologist on the noxious and beneficial insects of the State of Illinois. It is the eighth report of S. A. Forbes, for the years 1893 and 1894 (1896); with a separately issued appendix on the Mediterranean Flour Moth (*Ephestia kuehniella*, Zell.) in Europe and America, by W. G. Johnson, Assistant Entomologist. These reports are drawn up in the usual elaborate American manner, and the main report is chiefly devoted to the Chinch Bug (*Blissus leucopterus*, Say) and to White Ants, and is illustrated with thirteen plates of a very miscellaneous character in connection with the ravages of these and other insects. Much attention is given in this report to experiments on the dissemination of vegetable parasites among insects.

THE latest number of the *Journal* of the Asiatic Society of Bengal (vol. lxiv. part ii. No. 3), contains articles of unusual interest and variety. Nearly three-quarters of the part are taken up with a list of the Butterflies of Sumatra, by Mr. De Nicéville and Dr. Martin; while Messrs. King, Prain and Pantling write on *Papaveraceæ*, new orchids from Sikkim, and on a new species of *Renanthera*. But in addition to these more technical entomological and botanical papers, Surgeon Lieut.-Colonel Ranking writes on artificial immunity to snake venom by inoculation or internal application, in ancient and modern times (compare Prof. Fraser's articles in recent numbers of NATURE); and Mr. Frank Finn commences a series of contributions to the theory of warning colours and mimicry, by recording his experiments in feeding a Babbler (*Crateropus canorus*) on protectively-coloured butterflies and other insects.

WE note the appearance of three new volumes in the extensive series which constitutes the Encyclopédie Scientifique des Aide-Mémoire, published by MM. Gauthier-Villars and G. Masson. One is the third volume on "Géométrie Descriptive," and it deals with changes of planes of projection, rotations, trihedrons, and polyhedrons. In "Calcul de Temps de Pose en Photographie," by M. H. Boursault, the complex problem of the conditions which affect calculations of the time of exposure is treated in a very satisfactory manner. Scientific photographers will find much exact and serviceable information in M. Boursault's little volume. A volume on "Les Tramways," by M. R. Seguela, is an account of methods and materials employed in the construction of tram-lines in France. the United States, Great Britain, and other countries.

THE volumes in Stanford's Compendium of Geography and Travel, now in course of reissue, have been subjected to such thorough revision and considerably enlargement, that they are practically new books. The work on Asia, for instance, first published in 1882 in one volume of 750 pages, has been expanded into two volumes of about 550 pages each, and the first, dealing with northern and eastern Asia, has just been published by Mr. Stanford. Mr. A. H. Keane is responsible for this volume, and he may be complimented upon the thoroughness with which he has performed his task of revision. If the forthcoming volume on southern and western Asia is as satisfactorily done as the one now published, the whole will form an admirable account of the geography of the Asiatic continent, and one which accurately records the results of the important expeditions made during the past few years.

RECENT events in the Transvaal have had the effect of increasing the number of visitors to the South African Museum, according to the annual report of the Trustees; and this connection is borne out by the fact that during January of the present year the number of visitors was 5574, three-fourths of which consisted of country people, while the other fourth consisted chiefly of new arrivals and inhabitants of the Cape Peninsula. Visits from the inhabitants of Cape Town are said to be comparatively rare. Several attempts were made during last year to procure some of the large South African mammals, but the Trustees have not yet been successful in obtaining specimens of the elephant, giraffe, hippopotamous, &c., to replace the defective ones in the Museum collection. A number of fossil remains procured by Mr. E. H. L. Schwarz from the Prince Albert district of the colony are being developed by him. Fragments of one of the fossil reptiles have been sent to Prof. Seeley for development and identification, and the animal has been provisionally named by him *Tetracynodon*. Reference is made in the report to the resignation of the Curator, Mr. R. Trimen, and the appointment of Mr. W. L. Sclater as his successor. We notice that on account of the increased requirements of the new Museum, the buildings of which were taken over by the Trustees at the end of last year, the annual subsidy has been raised from £1600 to £2000.

WE have received the meteorological results of the observations taken at the Bangalore, Mysore, Hassan and Chitaldroog observatories for the years 1893 and 1894. The stations were established by the Mysore Government, in accordance with the desire of the Government of India. In addition to the usual tables, the work contains diagrams giving the mean daily and monthly values of the various elements, and a map of the Mysore Province, showing the average annual rainfall for the twenty-five years (1870–1894). These diagrams exhibit at a glance the nature of the weather changes, much more easily than could be gathered from a mere collection of figures. They show clearly that the rise of temperature from the cold of January to the heat of March and April is much more rapid in Mysore than

at Madras, where the climate is tempered by the influence of the sea. It is interesting to observe the interval between the mean dry and wet-bulb temperature throughout the year, and the daily range of temperature; the latter varies greatly, amounting to nearly 34° at Hassan, in January. The highest shade temperature in the two years was 99°·5 at Chitaldroog, in April 1893.

THE *Quarterly Journal* of the Geological Society for May is an unusually thick number, and its contents cover almost as wide a range of geological subjects as could be brought together. Palæontology is represented by the presidential address on the history of the Crustacea by Dr. Woodward, who also contributes papers on Cretaceous Crustacea from Vancouver, and on the only known fossil Octopod; while Mr. C. W. Andrews discusses the Plesiosaurian skull, and Mr. P. Lake continues his work on a group somewhat neglected of late years by British geologists—the Trilobites—with a study of the Silurian species of *Acidaspis*. In stratigraphy, Dr. Hicks contributes a paper in which he claims the Morte Slates as Silurian, and reopens in a new manner the North Devon controversy, while Miss Elles and Miss Wood show that there are Llandovery beds in the Conway district. The British Cretaceous rocks are subjected to a most detailed correlation—as regards the Speeton series by Mr. Lamplugh, and as regards the Cenomanian by Messrs. Jukes-Browne and Hill; the former author urging that some of the strata dealt with are strictly Jurassic, while the two latter show that the true Cenomanian of France represents our Lower Chalk only, and not our Upper Greensand. The only Tertiary geology in the journal concerns the Basaltic plateaus of North-western Europe and the river-system of the old land across which the lavas were poured, described in a most interesting paper by Sir Archibald Geikie. This last paper, along with one on a part of the same subject—the Skye granophyres—by Mr. Harker, represents also the petrological contributions to the journal. Important evidence is adduced by Prof. Edgeworth David of a Permo-Carboniferous glaciation of Australia. Finally, Prof. Hull's paper on the geology of the Nile, and Mr. Hill's, on transported Boulder Clay, must not be forgotten.

AN elaborate monograph on "The American Lobster," by Prof. F. H. Herrick, forming a part of the *Bulletin* of the United States Fish Commission for 1895 (pp. 1–252), has been issued as a separate publication. The memoir contains the results of a masterly study of the habits and development or general biology of the lobster, and is illustrated with the lavishness which is a feature of official publications of the United States. Until comparatively recent years the lobster was singularly neglected by naturalists; nevertheless, Prof. Herrick gives at the end of his memoir a list of more than two hundred papers referring to the Crustacea, of which the lobster may be styled the king. The subjects of the chapters in the present contribution to this literature are: habits and environment, reproduction, moulting and growth, defensive mutilation and regeneration of lost parts, large lobsters, enemies of the lobster, the tegumental glands and their relation to sense organs, variation in colour and structure, structure and development of the reproductive organs, habits of the lobster from time of hatching until the period of maturity, history of the larval and early adolescent periods, and embryology of the lobster. It will be seen from this brief statement that Prof. Herrick has studied many phases of the general biology of the lobster, and in all of them he adds to the previous knowledge of the subject. His observations are of scientific value, and many of the facts described, more particularly those relating to the larval development and reproduction, have important economic bearings. After some statistics pointing to the decline of the lobster fishery in the United States, Prof Herrick remarks: "Civilised man is sweeping off the face of the earth, one after another, some of its most interesting and valuable animals by a lack of foresight and selfish zeal unworthy of the savage. . . . Thus, as we shall see, the American lobster occupies only a narrow strip along a part of the North Atlantic coast, and while it is probably not possible to exterminate such an animal, it is possible to so reduce its numbers that its fishing becomes unprofitable, as has already been done in many places. The only ways open to secure an increase in the lobster are to protect the spawn-lobsters, or to protect the immature until they are able to reproduce, or to take the eggs from the lobsters themselves, and hatch them artificially." For the sake of the persons engaged in the lobster fishery, it is to be hoped that measures will be taken in time to prevent its further decline in the United States.

THE additions to the Zoological Society's Gardens during the past week include a Caracal (*Felis caracal*) from India, presented by Captain E. F. Carter; a Spotted Cavy (*Cœlogenys paca*) from Trinidad, presented by Dr. F. G. C. Damian; a Common Otter (*Lutra vulgaris*), British, presented by Mr. Henry Laver; a Blue and Yellow Macaw (*Ara ararauna*) from South America, presented by Mrs. Browning; a —— Deer (*Cariacus paludosus*, ♂) from Paraguay, two Green-winged Doves (*Chalcophaps indica*), two White-backed Pigeons (*Columba leuconota*) from India, four Alligators (*Alligator mississippiensis*) from the Mississippi, four Dandin's Tortoises (*Testudo dandinii*) from the Aldabra Island, deposited; two Thick-tailed Opossums (*Didelphys crassicaudata*) from South America, four Gouldian Grass Finches (*Poëphila gouldiæ*), two Crimson Finches (*Estrelda phaëton*) from Australia, purchased; a Sœmmerring's Gazelle (*Gazella sœmmerringi*, ♂), two Striped Hyænas (*Hyæna striata*), an Egyptian Ichneumon (*Herpestes ichneumon*), two Libyan Zorillas (*Ictonyx lybica*), two Fennec Foxes (*Canis cerdo*), two Ruppell's Vultures (*Gyps rüeppelli*), four Egyptian Vultures (*Neophron perenopterus*) from Egypt, received in exchange.

OUR ASTRONOMICAL COLUMN.

THE RING NEBULA IN LYRA.—The appearance of the brightest of the ring nebulæ, as seen with the Lick 36-inch refractor, is described by Prof. Barnard in *Ast. Nach.* No. 3354. The aperture of the ring was filled with a feebler nebulosity, which was estimated to be nearly midway in brightness between the brightness of the ring and the darkness of the adjacent sky. This aperture was more nearly circular than the outer boundary of the nebula, so that the ends of the ring were thicker than the sides. The following end of the ring had a slightly greater extension, which was less bright than the ring itself, and the entire nebula was of a milky colour. The central star was usually seen, but was never a very conspicuous object. The brightest region of the nebula lies in the northern part. Micrometric measurements of the nebula gave the following mean results:—

Position angle of major axis ...	65°·4
Outer major diameter	80″·9
Inner major axis	36″·5
Outer minor axis	58″·8
Inner minor axis	29″·4

A magnifying power of 520 was generally employed.

VARIABLE STAR CLUSTERS.—The discovery of a large number of variable stars in certain star clusters was announced a few months ago by Prof. E. C. Pickering (NATURE, vol. liii. p. 91). Since then a special investigation has been made of the variables forming part of the cluster M. 5 Serpentis, N.G.C. 5904 (*Ast. Nach.* 3354). Forty-five photographs of this cluster have been measured by Miss Leland, and the measures include the greater portion of the forty-six variables previously discovered. The periods of these variables are in general very short, not exceeding a few hours. One of these, designated No. 18, which follows the centre of the cluster about 6′ and is south 5′, has a probable period of 11h. 7m. 52s., or 0·4638

days. The coordinates of the light curve of this variable are as follows:—

Days.	Mag.	Days.	Mag.
0·00	13·50	0·25	14·73
0·05	13·87	0·30	14·73
0·10	14·35	0·35	14·72
0·15	14·70	0·40	14·65
0·20	14·72	0·45	13·56

It thus appears that the star remains about minimum brightness during half the period, while the maximum luminosity is of relatively short duration; the decrease in light is rapid, and the rate of increase still more rapid. The succession of changes does not seem to correspond with those of any previously known class of variable stars.

RECENT RESEARCHES ON RÖNTGEN RAYS.

THE novelty of Prof. Röntgen's skeletal photographs has almost worn off, and the field of research opened up by his observations is now mainly occupied by scientific workers, who are endeavouring to analyse the rays, and to extend the knowledge of their characteristics, rather than to produce startling pictures capable of exciting the wonder of the general public. But though the interest of scientific dilettantes has waned, the investigators who remain in the field are still so numerous that it is hardly possible to keep in touch with the multitude of observations published; and published in some cases, perhaps, a little prematurely. A number of interesting results have been recorded from time to time among our "Notes"; but so many papers and communications have been received during the past few days, that they are now brought together for readier reference, as has been done in several previous issues of NATURE.

Attempt to Polarise Röntgen Rays.

Dr. John Macintyre, whose observations on the capabilities of Röntgen rays have formed the subject of several letters and notes in these columns, has sent us an account of an attempt to polarise the rays. Different views have been expressed about the possibility of polarising the rays by means of tourmalines, and although Dr. Macintyre's experiments seem to indicate a negative result, they are of such importance that they deserve to be put on record.

The source of electricity was the main, and the measurements across the terminals (with Lord Kelvin's cell-tester and ampere gauge) were 10 volts and 10 amperes. The spark of the Rhumkorff coil was 6 inches, and a mercury interrupter was used. An ordinary Crookes' focus tube, enclosed in cardboard to exclude all light, was excited by the above, and the vacuum carefully arranged to give the maximum fluorescence by gently heating the bulb with a spirit-lamp. Screens of barium platino-cyanide, potassium platino-cyanide, and lithium-rubidium-platino-cyanide were tried. The two tourmalines were got as nearly alike as possible, the measurements of each being: length, 47 mm.; breadth, 12 mm.; thickness, 2 mm.; and the experiments were carried out in a dark room.

In the first experiment, on placing one tourmaline between the source of the Röntgen rays and the screen, and directly in contact with the latter, a distinct shadow was seen due to absorption of the rays. On placing the second tourmaline parallel with the first, a difference in density of the shadow was immediately observed. When the tourmalines were gradually turned at right angles to each other, a dark square area could be seen where the two crossed. A source of error was, however, suggested in this experiment. One of the tourmalines could not be in as close contact with the screen as the other; and on account of the manner in which the Rontgen rays pass from a point on the platinum plate in such a Crookes' tube, differences were observed in the shadows of the four arms of the cross formed by the tourmalines. For example, (1) if the horizontal tourmaline were next to the screen, and the vertical one behind it, the two arms above and below the square dark central area were less sharply defined than the two arms on each side of it, and consequently the shadows appeared to be different. (2) Although on the square portion corresponding to where the tourmalines crossed, one got a darker shadow still, it might only be due to the difference in thickness of the two layers.

A second observation was then made. One of the tourmalines was broken in two portions, and one of these was placed parallel with and the other perpendicular to the other tourmaline. Again the dark square area was seen by direct vision. Dr. Macintyre could not say, however, that the density was greater than where the other portion of the broken tourmaline was laying parallel with the whole one. This rather suggested that the square dark area was caused by difference of density only. In a third series of observations photographs were taken with different exposures—one with a single flash of the tube, due to one interruption of the coil; others with much longer exposures, but in all the same difficulties in distinguishing between the two conditions arose. (Copies of these photographs have been received from Dr. Macintyre.) In the first photograph a shadow of one tourmaline was obtained, proving the absorption of some of the Röntgen rays. In the second photograph, of one whole tourmaline and a portion of the other, a greater density can be noted where two layers are lying parallel with each other than where only one tourmaline interferes with the rays. The third photograph shows the unbroken tourmaline covered at one part by a portion of the broken tourmaline lying parallel with its axis. The other part of the broken tourmaline is placed at right angles, and Dr. Macintyre raises the question whether the density of the square area is greater than where the two tourmalines are lying parallel with each other. In his opinion, the photographs bear out the observations by direct vision, and appear to give negative results; and an examination of the two photographs which form the result of his crucial experiment, leads us to conclude that there is not any appreciable difference of brightness between them.

Röntgen Rays and the Resistance of Selenium.

Mr. J. W. Giltay, Delft, Holland, has sent us the following important communication on the influence of Röntgen rays upon the resistance of selenium.

Some weeks ago, the possibility of Röntgen rays having an influence on the resistance of selenium occurred to me. I made a preliminary experiment to put this idea to the test, but, probably owing to the poor state of my induction coil, I failed to get any effect. Want of time prevented me from trying again with another coil.

I told my failure to Prof. H. Haga, of Groningen University, who kindly undertook to investigate the subject. The selenium cell I made for him was of the Shelford-Bidwell type (NATURE, November 18, 1880), the working surface was 20 × 44 mm. The resistance of this cell was in darkness 31,600 ohms, in diffuse daylight it was about 15,300.

Prof. Haga with this cell got the following results, which I publish in this letter with his full approval.

The Crookes' tube he used was of the ordinary pear form (not a focus tube), and highly evacuated, giving undoubtedly a very strong Röntgen effect. The induction coil was one of Ruhmkorff's, of a length of 60 cm.; the battery for driving the coil consisted of five accumulator cells.

The distance between the selenium cell and the under part of the tube was 3 cm. The cell was covered with pasteboard, and over this was laid a thick sheet of zinc. The resistance of the cell was now measured by the bridge method, one dry cell acting as the battery, contact being of course made only momentarily. The resistance in the dark was found to be 31,600, as I remarked before. Now the induction coil was started and worked during just one minute; the resistance of the cell was then immediately measured again, and found to be exactly the same. This proved the wires carrying the induced currents and the coil itself to have no influence on the cell.

Now the zinc plate was removed and replaced by two thin aluminium sheets (two instead of one, to prevent heat rays falling on the cell). The coil was now worked during one minute, and immediately after stopping it the resistance of the cell was taken. This was now found to be 26,400.

The resistance was not measured *during* the radiation, else it would probably have been found to be a little less than 26,400, but immediately after the coil having been stopped. The measuring of the resistance took about one minute. After having left the cell at rest during 20′, the resistance had risen to 29,500 again.

Prof. Haga made several experiments, always with the same qualitative results.

A simple kind of bolometer, consisting of strips of tinfoil (11·85 Ω) did not show any change of resistance by Röntgen radiation.

It follows from these experiments of Haga's, that Röntgen rays act on the resistance of selenium in the same way as light and heat rays do. I think selenium will be found to be very useful in investigating the opacity of different substances for the Röntgen rays, and also for experimental work on the polarisation of those rays, as the deflection of a galvanometer is much easier to appreciate than the value of the photochemical action of the rays. It also follows from these experiments, that selenium is a very unfit material for making photometers.

It must always be kept in mind, when working with selenium, that the cell takes very little time in diminishing its resistance under the action of light, or other rays, but that it takes a much longer time (often half an hour or so) to return to its state of high resistance. It follows from this, that if one wishes to compare the action of two emissions, one must begin with the feebler radiation and afterwards let the stronger radiation hit the cell.

The Nature of Röntgen Rays.

The nature of Röntgen rays is so far from being settled, that the following remarks by Prof. W. N. Hartley, in favour of the ultra-violet theory, will be read with interest :—

The great doubt which prevails as to the nature of Röntgen rays arises from the fact that it is difficult to imagine radiations which make their existence manifest in a manner which, at first sight, appears very extraordinary.

Their intractability to the action of ordinary refractive media, and the facility with which they are transmitted by matter which has the property of absorbing light, has led to their being regarded as being propagated by vibrations differing in direction from those of other known forms of energy. I have given expression to the view on more than one occasion that they are simply ultra-violet radiations of much greater oscillation frequency than any we have yet been able to recognise and manipulate with prisms and lenses. The following comparison of the properties of the ultra-violet with those of the Röntgen rays are my reasons for this view :—

(1) Ultra-violet rays can be reflected and refracted.
(2) They are capable of energetic chemical action.
(3) They cause fluorescence.
(4) They facilitate the discharge of electricity through air.

(1) The Röntgen rays can be reflected, but have not hitherto been refracted.
(2) They cause energetic chemical action.
(3) They cause fluorescence and also phosphoresence.
(4) They cause the discharge of electricity through a non-conductor.

The ultra-violet rays are also subject to energetic absorption, which increases with the molecular mass of the absorbing substance in certain cases, but is dependent upon molecular structure in other instances. Röntgen rays are also absorbed energetically by some substances, and the absorption appears to be dependent upon the molecular mass of the absorbing medium, but in other cases it appears to depend upon what is probably molecular structure. Both the ultra-violet and Röntgen rays are revealed to us by their action on a photographic plate and on fluorescent substances, or rather substances which they render fluorescent.

The ultra-violet rays excite fluorescence in almost all substances, and with very remarkable effects in many cases (*J. Chem. Soc.*, vol. clxiii. p. 247, 1893). The effect of substances on the rays which enter them is to retard their rate of vibration. By retardation the length of the waves is increased to dimensions which bring them within the limits of visibility, and the result is either fluorescence or phosphorescence. This is usually expressed by saying the rays are lowered in refrangibility. It is quite probable that we may soon have evidence of refraction of Röntgen rays. They are undoubtedly reflected, since Jackson has shown that the most effective form of Crookes' tube is one in which a plate of platinum at an angle of 45° reflects the rays through the side of the vessel (*Proc. Chem. Soc.*, March 6, 1896).

Röntgen rays are in all probability of the same character as the ultra-violet rays; they produce the same effects, and no other rays are known to do this, except such as are of the same character and are capable of being "lowered in refrangibility," or retarded But it is evident that they must be of much greater oscillation frequency, or what amounts to the same thing, of much shorter wave-length than any which have hitherto been studied with lenses and prisms of rock-crystal or fluor-spar.

Mr. Jackson has declared his adherence to the belief that they are propagated by transverse, and not by longitudinal, vibrations (*J. Chem. Soc.*, vol. clxv. p. 734, 1894; also *Proc. Chem. Soc.*, March 6, 1896).

I have been induced to place these remarks on record, because in NATURE (p. 45) there appears an abstract of a paper in *Wiedemann's Annalen*, by D. A. Goldhammer, which renders it evident that from other considerations he is of the same opinion. He points out that the peculiarities of Röntgen rays are not inconsistent with transverse vibrations of very small wave-length. His reference to the absence of reflection appears to be not strictly accurate, so far as one may judge from the words of the abstract; but it is not fair to draw conclusions from an author's views without regard to his *ipsissima verba*.

Analysis of Röntgen Rays.

Mr. T. C. Porter, of Eton College, appears to have made an interesting discovery in connection with the Röntgen rays, viz. that they are of at least two different kinds. We print in full a preliminary account of the experiments which have led to this conclusion, with the remark that the photographs received just as we go to press entirely bear out the description.

A Röntgen tube (Newton and Co.'s and Griffin's focus tubes have been used in these experiments) emits two different kinds of rays. To one kind, which I venture to call X_1, flesh is fairly transparent, and bone opaque; to the rays of which this is a preliminary account, which will be called hereafter X_2, flesh seems nearly, if not quite as opaque as bone. Under ordinary circumstances, in the cold, using an induction coil ($3\frac{1}{2}''$ spark) and somewhat rapid hammer contact breaker, most, but not all, of the rays are X_1; but if the tube be heated, less and less of X_1 are emitted and more of X_2 until the fluorescent screen (mine is one of Messrs. Reynolds and Branson's, of Leeds, bright yellowish green in colour, and apparently of uranium glass, though of this I am not sure) shows the shadow of a hand held behind it sharply defined and very dark all over, *the bones not being visible*. The back of the screen is covered with a layer of very opaque (to ordinary light) thick black paper. Up to a certain temperature the green fluorescence of the glass of the tube increases very markedly, but the X_2 rays do not come from it, as the sharpness of the shadow shows; nor are the X_2 rays ordinary kathode rays, for the same discharge sent through a highly exhausted Crookes' tube showing "independence" of the positive pole failed to excite any fluorescence whatever on the screen, though the glass of the tube was fluorescing brilliantly opposite the concave kathode, and the violet cone of rays within the tube was plainly visible. At a certain temperature, judging from the fluorescence on the *screen*, the emission of these X_2 rays reaches a maximum, and on further heating the emission of any rays whatever capable of exciting fluorescence or photographic action falls off rapidly, though, so far as my experiments have gone, *some* fluorescence and photographic action have been plain up to the highest temperature to which I judged it wise to heat the tube. Wood and paper seem very fairly transparent to the X_2 rays, but glass seems very opaque, aluminium much more opaque than to the X_1 rays, judging by the following experiment, which shows best the existence of these radiations and their difference from the X_1 radiations.

A "Röntgen" whole plate was wrapped in two thicknesses of the black paper generally used for the purpose, and supplied with the plates by the Sandell Plate Co., and brought in darkness into the room for experiment, lit dimly by a single candle at some distance from the place where the plate was to lie. The plate was then laid film uppermost (still, of course, wrapped in the black paper) six inches below the exhausted tube (the latter placed in the usual position). A piece of plate-glass, one-third of an inch thick, was then laid over half of it, and a left hand laid on the other half, together with a piece of a small aluminium tray, and exposure was made for one minute with the exhausted tube cold (16° C.). The paper over the exposed half was then marked for the purpose of recognition; this half was then covered with the glass, to protect it from any further action, and the photographic plate turned in its own plane through 180° about a vertical axis, to enable the operator to place his hand on the other half in exactly the same way as at first. The tube was then heated with a spirit-lamp giving a large flame for about forty-five seconds, and, the left hand being in

position, the current was switched on for one minute: at the end of this time the appearance of the discharge in the tube showing that the latter was growing cold, the current was switched off, the spirit-lamp again applied to the tube with the right hand, the operator's left hand being kept rigidly in position over the plate, then the current put on again for a minute, and so on, the spirit-lamp and current alternately, till six and a half minutes' (the current at the last time ran a minute and a half) exposure had been given. The plate was then removed and developed uncut, with a hydroquinone developer, with the result that *whilst the far denser background of the last exposed half of the plate showed that it had received by far the greater amount of radiant energy* from the heated tube during its six and a half minutes' exposure, only the very faintest traces of the bone shadow could be made out in the very bold shadow of the flesh of the fingers: and on the other half, which had received but one minute's exposure to the cold tube, images of the bones were very clearly shown. This experiment proves that the radiation received from the hot tube resemble the rays hitherto called X rays (which I have called X_1) in being able to pass through paper opaque to ordinary light, but differ from them in being unable to pass through flesh, and in other ways, an account of which must be postponed for a short time. The effect of *cooling* the X-ray tube is being investigated.

I have spoken of these rays as a new *kind* of X rays. They may be related to the X_1 rays in the same kind of way as red is related to violet light, and if so are not essentially different. Hence I could think of no better nomenclature than to retain the letter X for them, and call them provisionally X_2; but *if they have the power of penetrating aluminium at all*, they certainly act in some respects so differently from the X_1 rays, that one might feel inclined to suspect them of some greater difference than the fluorescent and photographic experiments indicate.

Plant Structure Revealed by Röntgen Rays.

Mr. George J. Burch sends the following account of experiments from the University Extension College, Reading:—

Since February 13, I have been engaged, in conjunction with my colleague Mr. Dodgson, and Messrs. Herbert, Hooper, Soper, Twiney, West and Yetts, in a series of experiments with Röntgen rays. In investigating the influence of colour upon the relative opacity of certain substances, it occurred to Mr. West to compare a purple hyacinth with a piece of purple glass which had proved remarkably opaque. I found upon development that details of the structure of the flower were distinctly visible. Following up this clue, we have photographed a number of flowers with the Röntgen rays. By suitably arranging the exposure and the development, we can show the ovules inside the ovary in an unopened bud, the seeds within a seed vessel, and even the veins upon the white petal of a flower.

Apparently these results are due to refraction and reflection of the rays when the incidence is sufficiently oblique. Similar indications are visible in a photograph of a fish's eye prepared by Mr. Yetts, in which there is a narrow dark shadow that can only be due to internal total reflection. The feathers are seen in a bird by Mr. Soper, and a foot, developed by Mr. Herbert, shows the fabric of the stocking.

I am directing the experiments with the view of photographing the soft tissues of the human body.

A Photometer for Röntgen Rays.

All those who have had occasion to use Crookes' tubes to produce Röntgen rays will have noticed the extraordinary variations in the intensity of the radiation produced by an apparently trifling change in the vacuum and the make and break of the coil. A useful step towards some quantitative measurement of the intensity of Röntgen rays has been made by M. Meslin, who, in the current number of the *Journal de Physique*, gives an account of a photometer for the rays. The principle on which this photometer depends is the matching of the brilliancy of the two halves of a circular patch of barium-platino-cyanide, one half being rendered fluorescent by Röntgen rays, and the other rendered fluorescent by the light rays proceeding from some standard source, such as a candle or lamp. The light is passed through a coloured glass, so that the fluorescence produced has the same tint as that produced by Röntgen rays. The author finds that the barium-platino-cyanide, under the influence of Röntgen rays fluoresces with a light of such a colour that the maximum brilliancy occurs for a wave-length of about $0·500\,\mu$. The barium-platino-cyanide fluoresces most strongly when exposed to light having a wave-length of about $0·460\,\mu$. By means of this arrangement the author has been able to verify the law that the intensity varies inversely as the square of the distance, the following numbers being obtained:—

Distance of photometer.	mm.	mm.	Quotient.
From luminous source	350 ...	410 ...	0·853
From source of Röntgen rays	54 ...	63 ...	0·857

The Fluorescence of Photographic Plates.

As recently stated in NATURE (*ante* p. 62), it is well known that a photographic dry plate exhibits fluorescence when Röntgen rays fall upon it. With reference to this, Mr. Shelford Bidwell believes the seat of the fluorescence appears not to be in the sensitive film, but entirely in the glass support. Writing under date May 27, he says:—

I find that bromide, iodide and nitrate of silver do not by themselves show the slightest trace of fluorescence, neither does photographic gelatine; bromide paper and coated celluloid sheets are also quite invisible under Röntgen radiation. On the other hand almost any specimen of glass will, with a good tube, fluoresce sufficiently to show coins in a purse &c.; indeed, some of the pieces that I tried happened to be more efficient than any of the ordinary dry plates that were at hand.

No doubt certain photographic plates—possibly those used by Mr. Walker—are for special purposes prepared with fluorescent substances, and it is not surprising that such should fluoresce more strongly than others.

Miscellaneous Observations.

From the *Sitzungsberichte der Kaiserlichen Wiener Akademie* we learn that Prof. G. Jaumann has investigated the deviation of kathodic rays produced by electrostatic force. The rays follow the lines of electrostatic force, and such forces produce a strong deviation in the rays. This deviation is a temporary effect, which is soon brought to an end by the lengthening of the rays. Simultaneously with this electrostatic deviation of the kathodic rays, considerable variations take place in their intensity.

The similarity between the effects of Röntgen rays and of ultra-violet light on electrified bodies, forms the subject of a paper communicated to the Academy of Bologna by Prof. Augusto Righi, in which the author considers the influence of the pressure of the gas surrounding an electrified body on the discharge of its electrification produced by these rays. It appears that, under similar conditions, the critical pressure (that is the pressure of the gas corresponding to the maximum leakage) is greater for Röntgen rays than for ultra-violet rays. But the final charge of a conductor exposed to Röntgen radiations was found by Prof. Righi to increase with diminishing pressure of the surrounding air precisely as occurs when ultra-violet rays are brought into action instead. In another paper (*Atti R. Accad. Lincei*), the same writer dissents from Prof. J. J. Thomson's opinion that every dielectric becomes a conductor when it is traversed by Röntgen rays. Prof. Righi is of opinion that it cannot be considered as proved that a *non-gaseous* dielectric is rendered a conductor when it is traversed by these rays.

While recently experimenting with a Crookes' tube, Prof. Francis E. Nipher observed that the circular aluminium disc of the kathode became slightly loose on the aluminium wire, and that it was constantly rocking in rotary motion on the wire. After several days of use, during which it had been decided to construct a tube with discs capable of rotation, the kathode disc suddenly became loosened, and began to rotate slowly on the wire as an axis. The direction of rotation was contrary to the hands of a clock, when the disc was viewed from the point where the kathode wire pierces the wall of the tube. When the loose disc was made the anode, no tendency to rotation was observed. Up to May 4, when Prof. Nipher read a paper on the phenomena before the St. Louis Academy of Science, all attempts to produce the effect in air of ordinary pressure had failed. The experiment seemed to form a basis for imposing a term representing a rotation into the equations for force and potential within a wire conductor; but in a letter received a few days ago, Prof. Nipher suggests that a circular or elliptical vibration of the kathode wire might possibly account for the rotation of

the kathode disc. The tube on which the observation was made has been cracked, and now ceases to give the result; nor is he able to impart rotation in one direction only by familiar mechanical means that could have existed in the tube.

From across the Atlantic, correspondents of some of the daily newspapers have sent vague reports of several developments of Röntgen ray work. By coating the inside of a Crookes' tube with fluorescent crystals, Mr. Edison is stated to have produced an electric lamp in which "all the energy which in an incandescent lamp is lost in heat is turned into light. One of the new lamps of only four-candle power is said to give a light equal to that obtained by the usual sixteen-candle power incandescent lamp."

A report from the electrical laboratory of the State University of Missouri states that experiment shows that Röntgen rays kill the bacilli of diphtheria. Two guinea-pigs were inoculated with a culture of diphtheria. One of them was exposed for four hours to these rays, and showed no signs of diphtheria. The other died within twenty-eight hours, and the post-mortem examination showed that diphtheria was the cause of death. It hardly needs pointing out, however, that this evidence is not sufficient to justify the conclusion.

In *Cosmos*, M. R. P. Leray gives the first portion of an article on kathodic rays and the kinetic theories of their nature. The writer points out that although recent investigations have cast some doubts on Crookes' original "radiant matter" theory, no satisfactory alternative theory has been suggested. M. Poincaré has propounded the hypothesis that the phenomenon is produced like a luminous phenomenon, but, as he remarks, this is a very strange form of light. M Leray considers that this substitution of the ether for radiant matter, while failing to account for the earlier experimental results, affords no explanation of recent discoveries. The kinetic theory should not be abandoned, simply because it does not account for all the observed phenomena, until some theory has been suggested that better accords with fact.

Finally, in the *Naturwissenschaftliche Wochenschrift*, Prof. B. R. Borggreve offers a theory of the existence of Röntgen rays, and considers particularly the relation of Röntgen's discovery to Le Bon's so-called "dark light."

THE RELIEF OF THE EARTH'S CRUST.

PROF. HERMANN WAGNER, of Göttingen, one of the best-known geographers and statisticians of Germany, has recently published in *Gerland's Beiträge zur Geophysik*, a critical study[1] of a somewhat exceptional kind. The moral of the criticism is that the agreement of the final results of a prolonged series of calculations is no proof of the correctness of the individual stages of the work, and the application is that no elaborate series of calculations should be built upon until every step has stood the test of independent verification. One is tempted to suppose that all scientific workers believed in these principles, and that the steam-hammer strokes of Prof. Wagner's ponderous criticism are really more valuable in forging a firmer structure of fact, than for the sparks of proverbial philosophy elicited by battering the work of pioneers. The solid outcome of the investigation is the most detailed calculation yet arrived at of the area and volume of the portions of the earth's crust above and below sea-level, leading to a new and interesting division of the surface of the lithosphere into regions of special morphological character. Although this comes last in the discussion, we prefer to place it first in the appreciation, because constructive work is always more pleasing to contemplate than destructive efforts, and because those who, like myself, have been somewhat severely handled by Prof. Wagner, will probably be most willing to acknowledge the superior accuracy of his results.

The question of the completeness of the data from which these results are derived, and their fitness for such minute treatment, I shall consider later.

By means of the hypsographic curve connecting elevations and percentages of area (previously employed by Penck in his discussion of Murray's data) derived from measurements of height, depth and area of land and water, the surface of the lithosphere is divided by Wagner into five regions in place of the three suggested by Dr. John Murray, and hitherto accepted by most physical geographers. The five are as follows. The *Culminating Area* of the earth's crust, occuping 6 per cent. of the surface, and lying altogether above 1000 metres, with a mean height of 2200 metres (or 7200 feet) above the sea. The *Continental Plateau*, occupying all the surface from the 1000 metre contour-line of elevation to the 200 metre contour-line of depth, *i.e.* to the margin of the shallow sea-border or continental shelf. It comprises 28·3 per cent. of the surface, and has a mean elevation of 250 metres (or 800 feet) above the sea. The *Continental Slope*, from a depth of 200 metres to 2300 below sea-level, covers 9 per cent. of the earth's surface, and has a mean depth of 1300 metres (or 4300 feet). The *Oceanic Plateau*, between the depths of 2300 and 5000 metres, occupies no less than 53·7 per cent. of the surface, and has a mean depth of 4100 metres (or 13,500 feet). Finally the *Depressed Area*, deeper than 5000 metres, is assumed to occupy 3 per cent. of the surface, with a mean depth of 6000 metres (say 20,000 feet). In this classification of regions the coast-line is ignored, the abrupt change of slope at 200 metres (or rather the familiar 100-fathom line of our charts) being rightly given the greatest weight in a hypsographic study. The mean level of the surface of the earth's crust is placed by these calculations at a depth of 2300 metres, or 7500 feet below actual sea-level. The area of the continental-block, or region above the mean level of the crust, is found to be 43·3 per cent. of the surface, leaving 56·7 per cent. for the deeper region, instead of the 50 per cent. to which my first estimate of mean-sphere-level from Murray's data pointed. Although I suggested in April 1890, the restriction of Murray's term Abysmal Area to the ocean-floor below mean-sphere-level (instead of including everything below 1000 fathoms), and to class the whole slope up to sea-level as the Transitional Area, keeping the term Continental Area for the land; I gladly recognise the importance of Wagner's new division into five zones, as shown on the accompanying curve (p. 113). Two further subdivisions might be appropriately introduced—the *Flat lands* below 200 metres of elevation, and the *Continental Shelf*, or shallow sea above 200 metres of depth. From the anthropogeographical point of view, these are the most important regions of the globe. The height of 200 metres above actual sea-level corresponds by Wagner's showing to the mean level of the physical globe (lithosphere and hydrosphere), and is thus as fitted to be a limit as is the line of mean-sphere-level itself.

The total area of land is worked out at 28·3 per cent., and that of sea as 71·7 of the earth's surface, certain assumptions being made for the unknown polar regions. The ratio of land to water surface is thus 1 : 2·54. Other interesting levels are that of the mean height of the land 700 metres (or 2300 feet) above actual sea-level; and of the condensation spheroid, *i.e.* the physical globe if the water were condensed to the density of the rocks of the crust, 1300 metres (or 4260 feet) below present sea-level.

While Prof. Wagner has sought to give more exactness to the calculations on which our knowledge of the forms of the earth's crust depends, he has shown little sympathy with any suggestions towards an explanation of terrestrial relief. We have not space at present to consider his criticism of the remarkable relations between the various natural divisions of the crust involving the ratio of the densities and volumes of land and sea pointed out by Romieux in December 1890. Similarly the strictures on Penck's "Morphologie der Erdoberfläche" may be left for that distinguished physical geographer to treat personally.

The problem of finding the areas and volumes of the portions of the earth's crust above water or covered by water, and so of arriving at some knowledge of the true forms of the earth's crust, has been attacked by several physical geographers during the last twelve years. Prof. De Lapparent, in 1883, was the first to repeat Humboldt's attempts in this direction. Dr. John Murray, in 1888, published a very elaborate calculation based on contoured maps specially prepared by Bartholomew on Lambert's equivalent projection on the scale of 1 : 45,000,000. This work was criticised on publication by Prof. Penck and Dr. A. Supan, but attained wide acceptance. Prof. Wagner, for the purposes of his well-known statistical annual, "Die Bevölkerung der Erde," had collected the best estimates of the areas of the various continents and countries, and has caused corrections and new measurements to be made from time to time. All this work may be said to depend on the measurement of

[1] "Areal und mittlere Erhebung der Landflächen sowie der Erdkruste. Eine kritische Studie insbesondere über den Anwendungsbereich der Simpson'sche Formel" Von Hermann Wagner. *Gerland's Beiträge zur Geophysik*, II. Band, 2-4 Heft (1895), pp. 667-772.

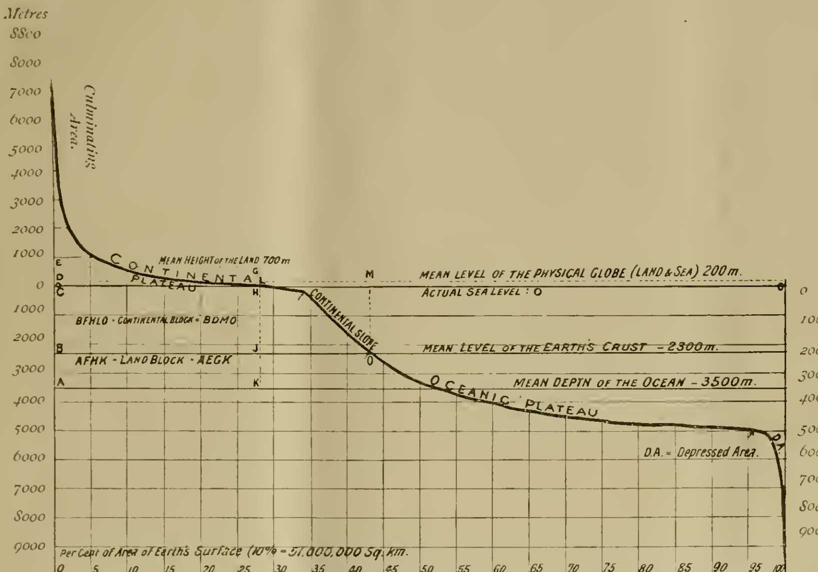
areas on maps by means of the planimeter. In 1891 Dr. Heiderich, a student of Prof. Penck's, published a series of calculations of areas and volumes of land and sea, based on an entirely different process. His method was to draw profiles of the earth's crust from contoured maps along parallels 5° apart, from the highest northern to the highest southern latitude for which data could be found. The areas of land or water for each zone of 10° of latitude wide were calculated from the length of the land or water on the three parallels 5° apart, by Simpson's formula

$$F = h/6\ (d + 4d_1 + d_2)$$

where F = the area of the zone 10° wide, h the value of the 10° interval in units of length, d, d_2 the length of the land (or of water) on the parallels bounding the zone, and d_1 the length on the parallel midway between them. Then using the *areas* of the profile above or below sea-level on each parallel, the volume of land (or of sea) in a zone of 10° is calculated by the same formula; in this case F standing for volume, and d for measured areas.

much importance. Were it not for the balancing of innumerable errors of measurement, we could not hope to gain any information at all from planimeter work on small scale maps, and no two independent measurements could possibly agree. Visible errors must of course be excluded by the exercise of all possible vigilance; but even in Prof. Wagner's critical pages there are one or two examples which show that the best intentions, the utmost vigilance, and a life-long experience of the desperate deceitfulness of proofs cannot guarantee perfect accuracy. On page 688 "II." occurs instead of "IV." in a reference to a volume, but the date being given correctly neutralises the error. On page 738 "g" should be "g_1" in referring to the mathematical formula there given, and on page 745 the expression "9,620,000 qkm. (9,000,000 + 6,200,000)" contains just such an oversight as might very seriously vitiate a calculation, the last number being obviously intended for 620,000.

The results obtained by Murray in 1888 are criticised in detail, and various sources of error pointed out. The corrections we do not hesitate to accept, but we cannot look on the original work as claiming the degree of accuracy which Wagner's criticism



WAGNER'S HYPSOGRAPHIC CURVE.

Prof. Wagner's main effort is to show the errors of Heiderich's work, first by comparison with his own new planimeter measurements, and then on theoretical grounds from the consideration of the natural difficulties introduced in Simpson's formula. In the former task Wagner was able to confirm his own estimates of the area of the land in a very neat and satisfactory way by comparison with Karsten's measurement of the oceans in zones of 10°, and he had the satisfaction of finding that the two sets of figures when added together gave a near approximation to the calculated area of the zones. The nett result of the inquiry is to show that Simpson's formula to be satisfactory must be applied to narrower zones than 10°, and that means must be taken to ensure that the intermediate values, which have four times the weight of either extreme in the final result, are really typical of the whole intermediate region. But Prof. Wagner enters into the minutest criticism of Heiderich's work, detecting errors of calculation and of typography, and showing how the use of round numbers gives rise to fresh errors in the totals. The balancing of errors which produces a fair consistency in the final result is interesting, but we believe that it receives too

implies. Had Murray's measurements been made on maps of a much larger scale, contoured at the same intervals, the results would probably have been nearer Wagner's; but we must also remember that it is the stimulus to this particular study, given by Murray's work, which has, in the ordinary course of the advancement of science, furnished his critic with data superior to those possessed in 1888.

While in several places Prof. Wagner acknowledges that his figures are only approximations, with no claims to absolute exactness on account of the uncertainty of the data, it does not appear that he realises the magnitude of this uncertainty. In the first instance measurements, even on large scale maps, are so difficult that increased precautions almost always show different results. The best example is in the case of France, where the re-measurement on the plates of the 1 : 80,000 map in 1894 showed that the area of that country was 1·48 per cent. greater than had previously been supposed. Again, it must be borne in mind that outside Europe, India, and some parts of the United States, there is not a single continental coast-line the position of which can be taken as correct. Some coast-line has to be assumed, but, except on

small-scale maps, the true position is not likely to lie within the thickness of the stroke which marks it, and deviation means change of area. Finally, we have the vast uncertainty of the utterly unknown Antarctic and Arctic regions, which are estimated by Wagner to amount to 16,000,000 and 5,000,000 square kilometres respectively, or together 4 per cent. of the whole earth's surface. In the face of all this uncertainty, does it not seem that only the balancing of errors can give an approximation to the truth regarding the areas of land and water; and that from the circumstances of the case, the fact that one set of estimates disagrees with another, independently made, is of small account? While every precaution should be taken to exclude errors of computation or of typography, it may be affirmed as a principle, that to subject uncertain data to a too rigorous discussion is waste of labour. Round figures alone can be justified for many a long day in estimating the areas of the earth's surface, and for longer still in estimating the volumes of oceans and continents.

The contour-lines on any ordinary map of a continent are only the roughest generalisation of the height, even when numerous points of altitude are fixed by exact levelling. But where a whole continent, like Africa, is measured for volume by the few barometer and boiling-point altitudes which have been taken by travellers of varying skill and in unknown meteorological conditions, the most laborious calculation can only be an elaborate guess. The temerity of the map-draughtsman in laying down the contour-lines of the oceans is justifiable as the expression of probability, not as any exact delineation. In the Atlantic they may indeed be guessed at with some confidence, but in the Pacific and Southern Oceans the mean depth might easily be hundreds of fathoms greater or less than is supposed from the scattered points which have been measured as yet.

It is right to guess at mean measurements, and to reason hypothetically from them, but there is a risk of men accustomed to critical rather than to practical work being misled against their knowledge by the firm lines of maps and the means of ingeniously grouped observations. That Prof. Wagner has obtained the best results possible by means of his calculations we recognise with sincere pleasure, but he has had the good, though naturally imperfect, work of others to start from, and a reader of his criticism might be led to disparage those workers but for whom the ambitious attempt to calibrate the earth's inequalities might have been postponed for another century.

For myself I gladly accept the new value of the mean-sphere-level as better than the avowedly rough guess which I hazarded six years ago. And although Prof. Wagner calls me "a friend of round figures," with a touch of rebuke in his tone, I shall still try to deserve the name in connection with such calculations until the improvement of geographical measurements justifies the use of decimals in percentages, and fifties of fathoms in average oceanic depths.

HUGH ROBERT MILL.

THE WORK OF LOCAL SOCIETIES.

THE practical methods of modern biological research have been developed to such a high state of perfection since the introduction of the appliances of physics and chemistry, that the system of training in biology has within a comparatively short period undergone a complete revolution. As one result of this change the student is tempted from the fields and hedgerows, from the downs, heaths and woodlands, from the banks of streams, and from the sea-shore into the laboratory. He knows the structure of a certain number of "types," but he walks as a stranger among the living animals and plants that surround him. His knowledge is not of that kind attributed to the wise king who "spake of trees, from the cedar-tree that is in Lebanon, even unto the hyssop that springeth out of the wall: he spake also of beasts and of fowls, and of creeping things, and of fishes." The organism is to the modern student not a living entity having a beautifully adjusted relationship to its environment, but a complicated collection of tissues capable by appropriate treatment of being spread out into a panorama of thin slices. His acquaintance with the living plant or animal is of about the same kind as that which a chemist ignorant of mechanics would acquire by endeavouring to understand the working of a watch by making a chemical analysis of its wheels and springs. In brief, the extreme specialisation of laboratory work begins too early in his curriculum. Since the introduction of the system of instruction by "types," there has arisen an estrangement between the old school of field naturalists and the modern biologist—a result which was not anticipated by the founders of this system, and against which a healthy reaction, led by Mr. Thiselton-Dyer and others, is beginning to take place.

It is true that certain departments of biology have gained enormously by the introduction of modern methods, and it must also be admitted that some branches, such as morphology and physiology, are best dealt with in laboratory and dissecting-room. But at the same time it is to be deplored that the department which Prof. Ray Lankester has happily termed "bionomics" should be allowed to suffer by competition with the new methods. If biology has gained in some directions, it is certainly the case that as a subject for the scientific training of the observing faculties, it has suffered deterioration by leaving the field naturalist outside the pale. The latter, finding himself threatened with scientific excommunication, is driven into the pages of popular magazines, or writes books which, although often very pleasant reading, are painfully sterile from the purely scientific point of view, and most disappointing when the capabilities of the writers are taken into consideration. Between the cabinet systematist who studies nature in museums, on the one hand, and the laboratory worker, who ignores the animal or plant as a living organism, on the other hand, the student of the old school of natural history is being hard pressed to find a footing. In a country like ours, with its immense colonies and dependencies in every quarter of the globe, it is most regretable that our educational authorities do not recognise field natural history as a subject worthy of their most serious encouragement.

While the modern development of biological teaching has led to the result above indicated, the local societies of this country have, in an unpretending way, been doing good work by keeping alive the spirit of the old school of naturalists. There are now on the list of Corresponding Societies of the British Association sixty-three societies distributed over the United Kingdom.[1] All of these are more or less actively engaged in carrying on local observations in various fields of science, and their very existence is good evidence that there is a store of available energy in this country which is by no means a negligible quantity in estimating the scientific status of the nation. Field natural history forms a large part of the work of these societies, and this is certainly one of the directions in which every encouragement should be given by all who are interested in their welfare. Under field natural history would be included the collecting and recording of species so as to furnish materials for the compilation of local faunas and floras, observations on the habits and life-histories of individual species, the systematic recording of dates of appearance of species, &c., comprised under the general subject of phenological observations. The local societies have already done much work in these subjects, and much more remains to be accomplished. In connection with the collecting of specimens it might be well to point out that these societies can do an enormous service by discouraging on every occasion the unnecessary destruction of life—by teaching by precept and showing by example that the mere acquisition of specimens is not the end and aim of natural history work, and that when a typical collection has once been formed the needs of science have been met. Most particularly is the assistance of the local societies wanted in protecting the "lower orders" of the animal kingdom and the rare species of plants from the depredations of the "dealer" or the avarice of the collector, for while our birds are now likely to flourish under a beneficent Act of Parliament, it is impossible to make a public appeal to the argument from sympathy with sentient beings in the case of the invertebrate classes of animals, or in the case of the rare plants which still linger in unfrequented districts. These are cases fo appeal to scientific reason rather than to sentiment. Is it too much to hope that the societies in each district should approach the landowners on whose estates rare species are know to occur, and invite them to co-operate in securing the protection of our choicest forms of animal and vegetable life?

In many other directions is there scope for useful scientific work on the part of local observers.[2] In geology, for instance,

[1] The total number of members registered as belonging to these societies is nearly 24,000. It is of course difficult to arrive at the actual numbers, because the same member may belong to more than one society; but after making every allowance for such repetitions, it will be seen that the volunteer army of scientific workers is much stronger than has hitherto been realised.

[2] For some valuable suggestions with respect to meteorological work, see the address to the Conference of Delegates at the last (Ipswich) meeting of the British Association, by Mr. G. J. Symons, F.R.S., Chairman of the Conference.

temporary sections are often exposed, which a resident in the district might take the opportunity of sketching or photographing and describing while the chance is open to him. Such opportunities are frequently lost owing to the temporary character of the work which has necessitated the excavation, and the absence of a qualified observer at the right time. It cannot be made too widely known to the members of local societies that every extensive artificial excavation is worth calling the attention of geologists to, and particularly when the society comprises no geological expert in its own ranks, because external aid might then be solicited before it is too late.

There are also certain special lines of geological work in which local co-operation has been found of great value, such, for instance, as the recording of the rate of erosion of sea-coasts, the distribution, mode of occurrence, mineralogical characters, &c., of erratic blocks, the height of water in wells, and so forth. These investigations have been, or still are being, carried on by British Association Committees, and are mentioned here simply as illustrations of the kind of work in which the members of local societies might take part. In anthropology and prehistoric archæology there is also abundant scope for local effort in the way of registering ancient remains, conducting systematic explorations, and assisting in their preservation by the appointment of vigilance committees. The needs in this department of science have been set forth in the reports of the British Association Ethnographic Survey Committee, and have from time to time been referred to in these columns in the reports of the conferences of delegates of Corresponding Societies.[1]

Thus, while there is plenty of work for local observers to do, and while the efforts which have been made in the past, and which are still being made by the provincial societies are worthy of the highest commendation, it cannot be denied that the energies of our local workers are not altogether as productive as they might be made for the cause of science. To point out a few of the reasons why the scientific activity of local societies is not producing the best possible results in the way of original investigation, may go some way towards suggesting remedies. In the first place, there is very frequently a want of co-operation between workers in the same or in neighbouring districts. This leads to a frittering away of energy by several people doing the same thing independently and unnecessarily. Such want of co-operation often arises from petty local jealousies which, however contemptible, may be powerful enough to cripple progress. Perhaps the best way to ensure co-operation is to bring the societies of the same or neighbouring counties into occasional intercourse by means of a system of federation. The Unions of naturalists' societies, such as those of Yorkshire, the Midlands, and the East of Scotland, have done good service in this way. As we have already announced, a Congress of Societies of the South-east of England was held at Tunbridge Wells on April 25. On a wider scale the British Association has for the last eleven years been giving facilities to the representatives of local societies all over the country for meeting and holding annual conferences under the official auspices of the Association. Not the least important feature of these conferences, which are regularly reported in these columns, is the opportunity which they give the delegates of learning directly from scientific experts the particular lines of work in which local co-operation is likely to be of real value to science. The work of some of the Association Committees has in this way received considerable local support, but on the whole the assistance given is not as great as could be wished. It may be useful to attempt an analysis of the causes why such aid has not been more freely rendered.

Any one who looks into the publications of local societies, or who is acquainted with the details of their management, must become impressed with the fact that the greater part of the work is done by amateurs. We do not use this term in a disparaging sense; on the contrary, it redounds to the credit of this country that so much work should be done by amateurs. But the workers of this class, however enthusiastic, are often devoid of scientific training, and are still more generally prevented by other occupations from carrying on continuous observations in any one subject. Hence the sporadic character of the work published, the want of co-ordination, and the difficulty of getting adequate assistance for the systematic recording of observations required by the prolonged inquiries undertaken by the British Association Committees. Another weakness which the amateur often possesses is the tendency to cope with too wide a range of subjects, and a desire to take in hand the whole circle of the sciences rather than devote himself to the drudgery of detailed observation in one limited field. Much good would result if it could be brought home to those who really desire to further the cause of science by local work, that the united efforts of a number of workers, each labouring in his own little domain, is in the long run the best of all methods for advancing knowledge by original contributions. If the amateur would curb his ambition, and take counsel with his co-workers, the volumes of some of the publications which have come under our notice would shrink in size, but the literature of science would gain considerably thereby.

The most promising remedy for these and other defects which are incidental to associations composed of more or less fluctuating elements appears to be the system of federation, if it can only be effected practically so as to over-ride the petty local narrowness which so frequently prevails. By co-operation the general level of the work done would be raised; it would be made more obvious to each worker that the cause of science is the one determining influence that should bind together the members of the society and the society to the Union. Numerous other advantages would naturally follow the adoption of such a course. Not the least important of these is the improved status which each society would gain by being affiliated with its neighbours. If the status is raised more support might be looked for from the wealthy county residents, who, although not themselves personally concerned with scientific work, might feel it a duty to encourage the county society. It may be pointed out incidentally that one of the most frequent causes of the collapse of local societies is the want of pecuniary support. This at least is the proximate cause; but the ultimate cause in such cases is as often as not the diminishing activity of the society itself, and the consequent loss of interest in its proceedings. It is confessedly difficult to keep up continuous active interest among such fleeting associations of members as compose the rank and file of the local societies. Many join at the foundation, carried in by a wave of temporary enthusiasm which soon dwindles down to an evanescent ripple, ending in the dead calm of indifference and ultimate secession. Or, again, the officials who float the society with all the enthusiasm of novelty may leave the district, or, worse still, kill the creation of their youth by the decrepitude of old age, and by tenaciously holding office convert the association into "a one man society" with a fossilised official for its executive. Truly it has been said that a local society is just what its secretary likes to make it. With federation and co-operative action there would arise a stimulating influence tending to prevent the decline of any one of the federated societies through these or any other of the thousand natural causes that affect the healthy existence of such associations. There would also be added to these beneficial effects an increased element of stability and permanence, more particularly if the societies constituting the federation were bound together by having one common publication. With respect to this last suggestion, there is everything to be said in its favour from the point of view of economy, from the point of view of avoiding the unnecessary duplication of editorial work, and, not least, from the point of view of diminishing the amount of printed matter which the scientific reader is now supposed to assimilate.

Many other aspects of the work of local societies might have been dwelt upon with advantage, but this want of centralisation appears to be one of the chief causes why their scientific productiveness is not commensurate with the number of workers scattered throughout the country. We should like to see the whole of the British Islands parcelled out into groups ot counties, each group being represented by a federation of all the societies contained in the counties composing the group. Such Unions are wanted, for example, by the South Eastern, the South Western, and the Western counties, as well as by East Anglia and other naturally associated groups of counties which will suggest themselves. The formation of these Unions would not only strengthen the societies already in existence, but would lead to the establishment of other societies in districts that were not already provided for. There is no reason why, in view of all the available scientific energy which is known to exist, the local society should not become a real power in each district—a centre of intellectual enlightenment worthy of public recognition and support in the same sense that every other

[1] See an article by the writer, in NATURE, vol. xxix. p. 19 (1883).

county institution has a claim upon the county residents. The foundation and maintenance of local museums is distinctly a part of the work of the local societies; in so far as these museums can be utilised for educational purposes, they have a claim to support from the County Councils, and in a few cases such support has actually been given. We note with satisfaction that the London County Council in the estimate for the expenditure by its Technical Education Board for the ensuing year has allocated a certain sum to "museums." The county of Essex is, we believe, unique in having attached to its Technical Instruction Committee a certain number of representatives of the local society. In agricultural and maritime districts where technical instruction centres round the sciences which are more particularly cultivated by the local societies, there is no reason why there should not always be co-operation between these societies and the County Councils. If such co-operation is at present the exception rather than the rule, it is because the local societies have not made their influence as intellectual powers felt with sufficient force. Let these societies knit up their scattered units, let their amateur workers be educated up to the necessity for carrying on systematic instead of casual observations, let them court the respect to which their labours entitle them by putting forth good evidence of activity, and they may play a far greater part in the scientific development of this country than has hitherto fallen to their lot. R. MELDOLA.

CAMPHOR.

CAMPHOR is not the exclusive product of any one natural order, genus, or species; but what is more remarkable, of closely allied species of camphor-yielding genera—one species possesses the secretion, while no trace of it is found in another. Although several kinds of camphor are articles of commerce, little, if any, reaches this country, save that obtained from *Cinnamomum camphora* (*Camphora officinarum*), a member of the laurel family, and of the same genus as the tree whose bark furnishes the spice called cinnamon. Like many other natural products of which scientific research has multiplied the applications, camphor is becoming dearer and scarcer, and the question has arisen, How is the supply to be maintained equal to the demand? The bulk of the camphor imported into Europe comes from Japan and Formosa, and comparatively little from China. This is the product of *Cinnamomum camphora*, and Dr. E. Grasmann has published [1] an interesting account of this tree, both from a scientific and commercial standpoint. He has rather overweighted his article with second-hand information respecting laurels generally and those of Japan in particular, which, as might be expected, is inaccurate in some details. Disregarding these, we find much that is interesting concerning the camphor-tree itself, which is one of the noblest objects in the forests of eastern sub-tropical Asia. It attains gigantic dimensions, surpassing all other trees of the Japanese forests, at least in girth of trunk if not in total height. Dr. Grasmann gives the recorded dimensions of various notable trees, but what is more to the point, he also gives measurements made by himself. A tree in the neighbourhood of the town of Miyazaki, Oyodomura, measured in 1894, was 14·80 metres in circumference at 1 30 m. from the ground, or 4 48 m. in diameter, and it was 35 m. high. There is an illustration of this giant reproduced from a photograph. Concerning the distribution of the camphor-tree in Japan, the author states that it grows naturally in Kinshin up to about 34° lat., and scattered in favourable situations some 2° farther north, the extreme limit being 36° 24′. It is abundant in the island of Formosa, and also occurs in the Tsusima and Luchu groups. On the mainland of China, according to Dr. Grasmann, it inhabits the coast region from Cochin-China to the mouth of the Yangtzekiang, and it may be added that it is now known to extend westwards at least as far as Ichang in the central province of Hupeh. From Dr. A. Henry's notes accompanying his specimens in the Kew Herbarium, it appears that the wood is in great request, but no camphor is extracted: and Consul Playfair reported the same from Pakhoi, Kwangtung, in 1883. Indeed the camphor industry would seem to be at present very limited in China, although the tree is common and widely spread. The little that is exported is mostly from the province of Fokien, but the amount is increasing in the same measure as the production is decreasing in Japan. In the latter country something has been done to maintain the supply, but Dr. Grasmann holds that the present rate of planting is wholly inadequate. He urges the importance of increasing the plantations to the greatest possible extent, inasmuch as every part of the tree is useful, from the roots to the young shoots and leaves. Even the fruit is employed in the preparation of tallow. In Formosa camphor distilling has been carried on in the most recklessly extravagant manner imaginable. It is suggested that Japanese rule in the island may put a stop to such disastrous waste.

With regard to the increasing price of camphor, it has been stated in various publications that this is due to its being used in the manufacture of smokeless powder. In reply to inquiries on this point, Sir Frederick Abel wrote to the Director of Kew in November last as follows:—

"Any increase of demand, involving a rise in the price of camphor, is not due to its application as a constituent of smokeless powder. That material was used in the earliest days of the manufacture of a successful smokeless powder for artillery and small arms; but its employment was soon demonstrated to be attended with serious practical disadvantages, and its application for the purpose can therefore not be said to have been other than experimental, and of no great importance, even at that time, as affecting the market value of camphor. This substance has, however, been used extensively for many years past, and no doubt in continually-increasing quantities, for the conversion of collodion cotton into the material known as celluloid, which is applied to the manufacture of imitation ivory, tortoiseshell, horn, and a great variety of purposes."

As Dr. Grasmann observes, the greatest enemy of the camphor-tree is man, and in Japan large trees are eventually killed through the felonious nocturnal grubbing of their roots. Some birds are fond of the fruit and seed, and the caterpillar of *Papilio sarpedon* feeds on the leaves; but, except to young plants, they cause comparatively little damage. Apart from the wanton destruction of trees, the probability of the supply of camphor being maintained is seriously diminished by the fact that the tree grows but slowly in its early years. At the same time it colonises freely, and is now naturalised in several countries, notably in Madagascar, where, according to Dr. Meller, in a note accompanying a specimen in the Kew Herbarium, it was abundant as long ago as 1862, and was much used for building purposes.

Next in point of importance in producing camphor is *Dryobalanops aromatica*, a tree belonging to the Dipterocarpeæ, and inhabiting Borneo and Sumatra. The formula of ordinary camphor is $C_{10}H_{16}O$; of Borneo camphor, $C_{10}H_{18}O$; and the latter can be artificially prepared from the former. Borneo camphor is deposited in clefts and hollows of the wood, and has simply to be taken out; but it is comparatively rare, and exceedingly dear, bringing eighty times more, according to Grasmann, than ordinary camphor. Nearly the whole production is imported into China, where it is esteemed beyond the ordinary camphor, and used as incense.

Blumea balsamifera (Compositæ), a shrubby plant exceedingly common in tropical Asia, yields a kind of camphor by distillation. Hainan is the principal seat of the industry, but the crude article is refined at Canton, whence there is an annual export of about 10,000 pounds. No doubt this source of camphor could be much more extensively utilised.

Members of various other natural orders, notably the Labiatæ, yield essential oils of the same composition, and having the same properties, as camphor. Menthol is an example.

W. B. H.

URANIUM.

THE introduction of the electric furnace by M. H. Moissan as an instrument of research, has opened up many new fields of work; among which the preparation of those metals whose oxides had been looked upon as irreducible by carbon, is not the least interesting. Three years ago the metal uranium was obtained in this way, and in a recent number of the *Comptes rendus* (May 18), M. Moissan gives a more complete account of the preparation and properties of this metal. The metal was isolated by three methods, by the action of sodium at a red heat upon the double chloride of sodium and uranium, $UCl_4 . 2NaCl$,

[1] "Der Kampferbaum. Mittheilungen der deutschen Gesellschaft für Natur- und Völkerkunde Ostasiens in Tokio," vi. pp. 277-315, with illustrations. 1895.

the electrolysis of this double salt in the fused state, and from the oxide, by reduction with carbon in the electric furnace. All three processes give good yields, the last-mentioned being the best, if care be taken not to unduly prolong the heating in contact with carbon, and to exclude air.

Metallic uranium, when pure, is perfectly white, and is not magnetic if free from iron. It is not hard enough to scratch glass, takes a good polish, and can be filed with ease; in the electric forge it is much more volatile than iron.

M. Henri Becquerel, in the same number of the *Comptes rendus*, gives an account of a remarkable property of this metal, which appears to be unique, that of emitting invisible phosphorescent rays capable of producing photographic effects after traversing opaque bodies such as cardboard, aluminium, copper, and platinum, and also able to discharge a gold-leaf electroscope. The effects produced are precisely similar to those previously obtained from uranium salts, such as potassium uranyl sulphate, except that they are nearly four times as intense. The chemical behaviour of uranium depends to a certain extent upon its state of division. The metal obtained by electrolysis, which is finely divided, takes fire in fluorine, is attacked by chlorine at 180°, by bromine at 210°, and by iodine at 260°, the reactions in all cases being complete. The powdered metal is completely burned in pure oxygen at 170°, and decomposes water, slowly at the ordinary temperature but more quickly at 100°. Uranium must be added to the rapidly increasing group of metals which combine directly with nitrogen at high temperatures. Fragments of the metal heated to about 1000° in a current of nitrogen become covered with a yellow layer of nitride, and hence in the preparation of the metal it is necessary to work in such a manner as to completely exclude air.

SCIENCE IN THE MAGAZINES.

THE celebration of the Kelvin jubilee at Glasgow on June 15–17, makes the appearance of an article on the renowned investigator, in the June number of *Good Words*, very opportune. The author is the editor, Dr. Donald Macleod, once a student of Lord Kelvin's, and his description of the master is a most appreciative one. Illustrations of Glasgow University, Lord Kelvin's class-room, laboratory, and study, and of Lord and Lady Kelvin, give additional interest to the article.

An excellent illustrated article on "The Rise of the Royal Society," is contributed to the *Leisure Hour* by Mr. Herbert Rix, the late Assistant Secretary of the Society. Other articles of scientific interest in the same magazine are "Notes on the Zoo," by Mr. W. J. Gordon, with illustrations from photographs by Mr Gambier Bolton; "The New South Africa," by Mr. Basil Worsfold; and "Modern Hygiene in Practice," by Dr. A. T. Schofield.

Science Gossip contains the first of a series of articles upon the scientific worthies at the National Portrait Gallery, illustrated with sketches of the pictures by Miss J. Hensman. We understand from the article that there are about thirty portraits of scientific men out of upwards of a thousand pictures in the Gallery.

An article on Africa since 1888, with special reference to South Africa and Abyssinia, by the Hon. Gardiner G. Hubbard, and accompanied by a striking portrait of the author, appears in the *National Geographic Magazine* (May). Another paper on Africa, "Impressions of South Africa," is contributed to the *Century Magazine* by Mr. James Bryce, M.P. In the *Contemporary*, there is an article by Dr. George Harley, F.R.S., on "Champagne," having medical as well as gustatory points of interest. *Good Words* has an article on "Aluminium," by Prof. Jamieson, and on "Flowers of the Forest," by Mr. Edward Step. Mr. W. H. Hudson has an article on "Ravens in Somersetshire" in *Longman's Magazine*. Among the popular articles in *Chambers's Journal* is one on "Photography in Colours," descriptive of Mr. Ives' process, and another on the Harvey process for hardening steel. Sir Robert Ball describes the planet Saturn in the *Strand Magazine*. Students of animal life may be interested in the second paper on "The Evolution of the Trotting Horse," contributed by Mr. H. Busbey to *Scribner*.

In addition to the periodicals mentioned, we have received the *Humanitarian*, *Fortnightly*, and the *Sunday Magazine*, but no articles in them call for notice here.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. H. J. HEINTZ has given 10,000 dols. to the Kansas City University, the corner-stone of which has just been laid.

THE Technical Instruction Committee of the Middlesex County Council have decided to offer a scholarship, worth £50 per year for two years, tenable at the City and Guilds of London Institute. This scholarship is to be competed for by boys to whom scholarships at secondary schools were awarded in 1893. It is to include school fees, railway fares, and maintenance.

THE following are among recent announcements:—Dr. Otto Fischer to be Extraordinary Professor of Mathematics in Leipzig University; Prof. L. M. Underwood to be called to the chair of Botany in Columbia University; Dr. George A. Dorsey to be Curator in the Department of Anthropology in the Field Columbian Museum at Chicago; Dr. Franz Boas to be Lecturer on Physical Anthropology in Columbia University; Prof. Harold B. Smith to be Professor of Electrical Engineering in the Worcester Polytechnic Institute.

FOR news of the following gifts to education and research in America, we are indebted to *Science*:—Mr. Thomas McKean has offered to give 100,000 dols. to the University of Pennsylvania upon condition that 1,000,000 dols. be collected. Mr. McKean, who is a trustee and an alumnus of the University, gave 50,000 dols. about a year ago.—Mr Charles M. Dalton has given the Massachusetts Institute of Technology 5000 dols. for a scholarship in chemistry for graduate students. Preference will be given to those undertaking chemical research applicable to textile fabrics.—Real estate and securities valued at 215,000 dols. have been presented to the North-western University by William Deering, of Evanston, who had previously given the University about 200,000 dols.

WE have to record another attempt to divert part of the funds available under the Local Taxation (Customs and Excise) Act, 1890, to the General County Fund. This time it is the Isle of Ely County Council. At their meeting held at March, on May 20, it was proposed "that £1000 of the Imperial grant be allocated to the General County Fund, instead of the £150 recommended by the Committee." The proposal was eventually rejected, it is true, but only by a majority of two in a meeting of forty. The argument which was used in the North Riding County Council a short time ago, and to which we called attention, was again repeated—that it was never the intention of Parliament for the whole of these funds to be devoted to the purposes of technical education. No stronger reason than such occurrences as these could be found for the necessity of the provision in the Education Bill that these funds must be devoted to educational purposes.

WE are glad to learn from *Science* that an effort is now under way in connection with the National Educational Association to bring about greater interest in the *teaching* of science than has hitherto been shown by American botanists, zoologists, chemists, physicists, &c. The new Department of Natural Science Instruction is intended to bring together the teachers of the natural sciences who are interested in science *as a means of culture*, and to stimulate thought and discussion as to how this end may best be obtained. What *rôle* should botany, zoology, chemistry, physics, &c., play in the mental development of man? In what way may the study of plants, animals, chemical compounds and physical forces be made an efficient factor in a man's mental training? When and how shall such study be made a part of a man's training? These are some of the questions which will be discussed in the Department of Natural Science Instruction in the Buffalo meeting of the National Educational Association, on Thursday and Friday afternoons (July 9 and 10).

THE Technical Instruction Committees of the Oxfordshire County Council have decided to devote £560 to scholarships during the next year. Of this amount £294 will be absorbed on account of the scholars already elected. The balance is to be devoted to further developing the scholarship scheme. Amongst other arrangements, we notice that it is proposed to elect three sons of tenant farmers to County Council scholarships of an annual value of £15. The candidates must have been under fourteen years of age on December 31, 1895, and must have lived in the county for two years previously. The scholarships will be held at Burford Grammar School for the first two years. Sums of £366 and £314 have been respectively allotted for capitation

grants and rural agricultural instruction. The programme for the year also makes the following provisions:—For dairy instruction, £250; for manual instruction in woodwork, £228; for nursing, ambulance, and general hygiene, £190; for dressmaking, £100; for instruction in poultry-keeping, £35; for hedging and thatching, £25. We are very sceptical as to the wisdom of so diffuse a syllabus of work, and would again point out that no efforts should be spared to coordinate and systematise all the educational projects of a County Committee.

A PROSPECTUS referring to the Faculty of Applied Science of McGill University, Montreal, announces that, through the munificence of Mr. W. C. McDonald, a Department of Architecture has been established in the Faculty, and the regular work of the new department will commence with session 1896-97. During the summer, a Professor of Architecture is to be appointed, and the efficiency of the Drawing Department is to be much increased by the addition of a lecturer in freehand drawing and descriptive geometry. The same benefactor has also rendered it possible for the University to place the Departments of Chemistry and Mining in a thoroughly efficient condition. The erection of a large building is to be proceeded with immediately, and the building will be equipped in the most approved manner, including not only provision for the several branches of chemistry, but also for mineralogy, mining, and metallurgy. The Mining and Metallurgical Laboratories alone will have a floor space of about 10,000 square feet, and will be supplied with the most recent appliances for the milling and metallurgical treatment of ores, &c. A Professor of Mining will be appointed during the summer, and other important changes in the staff, all leading to increased efficiency, are to be made.

SCIENTIFIC SERIALS.

Symons's Monthly Meteorological Magazine, May.—The worst gale of the nineteenth century in the English midlands. This storm occurred on March 24, 1895, and has not been fully discussed, although some local scientific societies have published short papers upon it. The present number contains part of the list of damage done in various countries; in the next number it is proposed to complete it, and to offer some general remarks upon the subject. Mr. Symons considers that the damage done is without parallel since "the great storm" of 1703. It is a curious coincidence that it occurred on the same day of the year, and nearly at the same hour, as that of the *Eurydice* squall in 1878, in which, it will be remembered, Her Majesty's ship was lost. This latter storm was discussed by the late Mr. W. C. Ley.—Fog, mist, and haze, by "F. R. Met. Soc." In the hope of initiating a discussion upon the existing absence of unanimity as to the meaning attached to the different words in general use, the author has suggested certain definitions, which are briefly as follows:—Fog; an obscuration due to condensation of aqueous vapour when the particles are too small to be seen with the naked eye. Mist; when the particles are large enough to be seen with the naked eye. Smoke-fog; obscuration without water particles. Haze; an obscuration of distant objects, so slight that the cause is not visible to the observer.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, May 7.—Mr. A. G. V. Harcourt, President, in the chair.—The following papers were read:—Carbon dioxide, its volumetric determination, by W. H. Symonds and F. R. Stephens. The authors describe a trustworthy method of estimating carbon dioxide in air.—On certain views concerning the condition of the dissolved substance in solutions of sodium sulphate, by R. F. D'Arcy. Experiments on the viscosity of strong solutions of sodium sulphate confirm the generally accepted view that the condition of sodium sulphate in aqueous solution is always the same, whether the solutions are prepared from the anhydrous salt or one of its two hydrates.—Luteolin, II., by A. G. Perkin. The results of the further examination of luteolin are given; it is isomeric with fisetin, and probably has the constitution

$$\begin{array}{l} \mathrm{C(OH).CH{:}C.CO - C.C_6H_3(OH)^2} \\ \| \qquad\qquad | \qquad\qquad \| \\ \mathrm{CH.C(OH){:}C.C(CO).CH} \end{array}$$

.—Morin, Part I., by H. Bablich and A. G. Perkin. Morin, a yellow colouring matter occurring in old fustic and in Jackwood, is isomeric with, and has a very similar constitution to quercitin.—Synthesis of pentacarbon rings. Part I. Anhydracetonebenzil and its homologues, by F. R. Japp and G. D. Lander. Anhydracetone benzil has been fully investigated, and is shown to be a diphenylhydroxycyclopentane of the constitution

$$\left.\begin{array}{l} \mathrm{CPh - CH} \\ | \\ \mathrm{CPh(OH).CH_2} \end{array}\right\rangle \mathrm{CO}.$$

—Synthesis of pentacarbon rings. Part II. Condensation of benzil with acetonedicarboxylic acid, by F. R. Japp and G. D. Lander. The behaviour towards reagents of anhydracetonebenzilcarboxylic acid, which is obtained by the condensation of benzil with acetonedicarboxylic acid, is described.—Reduction of desyleneacetic acid, and the constitution of Zinin's pyroamaric acid, by F. R. Japp and G. D. Lander. Desyleneacetic acid yields Meyer and Oelker's desylacetic acid on reduction and $\beta\gamma$-diphenylbutyric acid on boiling with hydriodic acid and phosphorus; this acid is identical with Zinin's pyroamaric acid.—Electrolysis of potassium allo-ethylic camphorate, by J. Walker and J. Henderson.—Flourene and acenapthene, by W. R. Hodgkinson. The red substance obtained by the oxidation of flourene and acenaphthene is not a hydrocarbon, but contains oxygen; no coloured hydrocarbon can be prepared by oxidising these substances.

Mathematical Society, May 14.—Major MacMahon, R.A., F.R.S., President, in the chair.—Mr. H. F. Baker spoke upon the bitangents of a plane quartic curve and the straight lines of a cubic surface.—A paper by Prof. E. W. Brown, on the application of the principal function to the solution of Delaunay's canonical system of equations, was taken as read.—Short communications were made by the President, Colonel Cunningham, Prof. Hill, F.R.S., Mr. Hammond, and Mr. Tucker.

CAMBRIDGE.

Philosophical Society, May 11.—Prof. J. J. Thomson, President, in the chair.—Note on the formation of the layers in Amphioxus, by Mr. E. W. MacBride.—Note on the continuity of the mesenchyme cells in Echinoderms, by Mr. E. W. MacBride.—Mr. F. C. Shrubsall read a paper on crania from Teneriffe, embodying the measurements of sixty-one skulls and two hundred long bones. The average height of the islanders, calculated from the latter, was for males 1642 mm. and for females 1552 mm.

EDINBURGH.

Royal Society, May 18.—Prof. Chrystal in the chair.—Mr. W. G. Robson, St. Andrews, exhibited some X-ray photographs, and described the progress of the study at St. Andrews University. Some of the exposures were long compared with what has been done recently, notably by Dr. Macintyre: but the photographs were all very good, and the definitions remarkably clear. Some of the pictures shown were very interesting. A photo of a mummy's foot was exhibited, and Mr. Robson remarked that the rays must have had some effect on the skin, for, at the end of the experiment, it was found to be quite soft. A photograph of what looked at first sight like some insect, but turned out to be a St. Andrews "bulger" with the lead showing very clearly, caused some amusement. Prof. Chrystal thought that uranium would be of great use in intensifying X-ray photographs.—Prof. D'Arcy Thompson made a short preliminary communication on the bird and beast names in Albertus Magnus. There were very many barbarous-looking names for beasts and birds in Albertus Magnus, which have a certain resemblance to words in Aristotle. The Dominican friar did not know Greek, but used an Arabic translation of Aristotle. If the Greek words were transliterated into Arabic, they were found to be parallel with the words used by Albertus when treated in the same way.—Prof. Thompson also read a paper on the Σ of Diophantus. Diophantus used Σ for an unknown quantity. Most commentators take this to be the *s* of *ἀριθμός* ("*ὁ ἀόριστος ἀριθμός*"), but there are difficulties attached to this interpretation. Sometimes the Σ has the sign of the genitive or plural written in small letters beside it, pointing rather to the fact of its being an initial letter. Prof. Thompson suggested *σωρός*, a heap, connected with the heap-calculus of the Egyptians, and gave various reasons for his suggestion. If true, this hypothesis, in linking Diophantus on to the Eastern culture, deprived him of his position as the father of mathematics, and helped to prove that many of his problems, as was conjectured long ago by Morgan and Bonnycastle, were not original but were collected from

Egyptian mathematicians.—Prof. Thompson next communicated a paper by a pupil, W. T. Calman, on the affinities of the genus *Anaspides* to certain fossil Crustacea. Mr. Calman's re-examination of this remarkable fresh water schizopod from Tasmania has resulted in the discovery of certain important features not observed by its discoverer, notably the presence of what appears to be a group of ocelli on the dorsal surface of the cephalic region. The significance of this, and other morphological peculiarities, was discussed at length, and the indications of divergent affinities with Decapods, Edriophthalmates, and other groups were pointed out. Finally, it was shown that *Anaspides*, while not closely comparable with any living crustacean, possesses strong resemblances to certain Palæozoic crustacea forming the groups *Syncarida* and *Gampsonychidæ* of Packard, whose systematic position has hitherto been a complete puzzle to palæontologists.—Prof. Tait indicated the nature of his paper on the linear and vector function, and promised to give it in detail at an early date.

DUBLIN.

Royal Dublin Society, April 22.—Prof. Grenville A. J. Cole in the chair.—Mr. J. R. Kilroe read a paper on the distribution of drift in Ireland, in its relation to agriculture. The relation between the drift and the underlying rocks was discussed, and the general mode of origin and succession of the glacial deposits in Ireland were described. The importance of considering the stones included in sands or clays as sources of fertilising materials was especially dwelt on, and illustrations were given of the physical and chemical constitution of numerous Irish drift deposits. A broad system of separation of the constituents was adopted, such as would be suited to agricultural requirements.—The following abstract of a paper by Prof. T. Rupert Jones, F.R.S., and Mr. J. W. Kirkby (communicated by Prof Sollas, F.R.S.), on the Ostracoda of the Carboniferous Formations of Ireland, was read March 18, but was not in time for publication in the report of that meeting sent to NATURE. In 1866 Messrs. Jones and Kirkby made a critical examination of all that had been published about the Carboniferous Entomostraca (Ostracoda) of Ireland, in the *Annals and Magazine of Natural History*, ser. 3, vol. xviii., pages 37–51. Having in the interval from 1866 received numerous species of Ostracoda (Podocopa) from the Carboniferous Formations of Ireland, the authors have put them, together with those already tabulated and described, in a convenient arrangement, so that geologists, and naturalists in general, should be able to form their judgment on this branch of the Palæontology of Ireland. Many of the specimens have been treated more or less fully in some of the authors' memoirs scattered in various publications (such as *Annals Mag. N. H.*, *Quart. Journ. Geol. Soc.*, *Geological Magazine*, *Proc. Geol. Assoc.*, *&c.*). Several, however, have not hitherto been adequately illustrated; and, lastly, some are new. Of the species and notable varieties, there are belonging to *Cytherella*, 7; to *Leperditia*, 10; *Beyrichia*, 3; *Beyrichiopsis*, 2; *Kirkbya*, 5; *Ulrichia*, 1; *Bythocypris*, 2; *Macrocypris*, 1; *Argillæciæ*, 1; *Krithe*, 2; *Bairdia*, 8; altogether 42. It is proposed to give a descriptive and bibliographic account of each form, with its range and localities, accompanied by good illustrations. The specimens treated of have come from Donegal, Londonderry, Tyrone, Down, Sligo, Longford, Mayo, and Cork.

PARIS.

Academy of Sciences, May 26.—M. A. Cornu in the chair.—On researches made at the observatory of Madison by G. Comstock, concerning aberration and refraction, by M. Lœwy. The constant of aberration given by these researches is 20″·44.—On the part played by the ring of iron in dynamo-electric machines: reply to the note of M. Potier, by M. Marcel Deprez.—Source and nature of the potential directly utilised in muscular work, from the point of view of the respiratory changes in man after fasting, by M. A. Chauveau. The ratio of carbon dioxide to oxygen, or respiratory quotient, mounts rapidly when muscular work is commenced, falling away, however, if the work is very prolonged. After a rest of one hour the quotient falls to the normal. Fat does not appear to be utilised directly by the muscles, even when the work is done fasting.—The immediate destination of fatty food, by MM. A. Chauveau, Tissot and de Varigny.—On the theory of gases, a letter from M. Boltzmann to M. Bertrand. M. Boltzmann points out that Maxwell himself stated the doubtful nature of his first demonstration. That this one demonstration is false, however, by no means implies that the theorem itself is false, and reference is made to independent proofs by Boltzmann, Lorentz, Kirchhoff, and others.—Reply to the preceding by M. Bertrand. Leaving Maxwell's first demonstration on one side, his second is equally indefensible. While reserving for the present a critical examination of the various proofs advanced, M. Bertrand thinks that, *à priori*, these proofs cannot be real, since all formulæ solving the problems proposed by Maxwell must contain one arbitrary function.—On the vapour pressures of some formic acid solutions, by M. I. M. Raoult. The observations were made by the dynamical method, and give a mean value of 0·713 for the molecular diminution of vapour pressure for formic acid used as a solvent. The ratio of the actual to the theoretical vapour density as found from this number is 1·55, the number obtained by Bineau by direct observation being 1·34.—Description of a mechanical flying machine, by M. Langley (see p. 80).—Letter from M. Graham Bell to M. Langley, on the same subject (see p. 80).—Observations of the sun, made at the observatory of Lyons with the Brunner equatorial during the first quarter of 1896, by M. J. Guillaume.—On the ordinary differential equation of the first order, by M. A. Korkine.—On the conditions of equilibrium of a certain class of systems capable of deformation, by M. B. Mayor.—On a new mode of regulating motors, by M. L. Lecornu.—Remarks on the preceding note, by M. H. Léauté.—On the magnetic torsion of soft iron wire, by M. G. Moreau. An experimental study of the action of a solenoid carrying a current upon a wire under torsion. The increase of torsion observed, called the magnetic torsion, is proportional to the square of the magnetising current, is independent of the diameter of the wire if the latter is small, and is always in the same sense as the original torsion.—Reply to a claim for priority of M. G. Friedel, by M. R. Dongier. The principle utilised was originally due to Fizeau and Foucault.—On the determination of the deviation of the Röntgen rays by a prism, by MM. Hurion and Izarn. The results obtained with an aluminium prism were entirely negative.—On the refraction of the X-rays, by M. Gouy. Using as the source of Röntgen rays the edge of the platinum disc in a Crookes' tube of the "focus" pattern, so that the origin of the rays is practically rectilinear, with prisms of aluminium and of crown-glass, the conclusion is drawn that the index of refraction of the Röntgen rays cannot differ from unity by more than $\frac{1}{200000}$.—Photometry of phosphorescent sulphide of zinc excited by the kathode rays in a Crookes' tube, by MM. C. Henry and G. Seguy. At a fixed pressure the brightness of the zinc sulphide falls off as the experiment is prolonged. There is a certain pressure at which the maximum intensity of light is obtained; a reversal of the current reduces the brightness to about $\frac{1}{17}$ of its original value.—Action of gaseous hydrogen iodide and phosphonium iodide upon thiophosphoryl chloride, by M. A. Besson. The reaction is analogous to that already described for phosphoryl chloride, the products being phosphorus tri-iodide, iodine, hydrogen sulphide, and hydrogen chloride.—On the hydration of pinacoline, by M. Maurice Delacre.—On a new mode of preparation of glyceric acid, by M. P. Cazeneuve. Glycerine is readily oxidised to glyceric acid by silver chlorid in alkaline solution. The acid is extracted by dry acetone, in which glycerine is insoluble.—Action of ethyloxalyl chloride upon aromatic hydrocarbons in presence of aluminium chloride, by M. L. Bouveault. Reaction readily occurs with benzene, toluene, and metaxylene, more difficultly with cymene, with production of the corresponding substituted glyoxylic ethers. With cymene, a new ethyl cymene is obtained as a bye-product.—New derivatives of the cyanoacetic ethers, by M. Guinchant.—Physiological study of the Cyclamens of Persia, by MM. A. Hébert and G. Truffant. The methods of high culture usually followed for these ornamental plants do not necessarily give the largest flowers, a rich soil giving large leaves and small flowers, a poor soil the reverse.—On a new soluble oxidising ferment of vegetable origin, by M. G. Bertrand. The browning of the cut surfaces of certain vegetables, dahlia, apple, and others, is due to the oxidation of the tyrosine under the influence of a soluble ferment, an oxydase. It can be isolated from the roots of the dahlia.—On the buccal and œsophageal pouches of the *Prosobranchia*, by M. A. Amaudrut.—General observations on the distribution of the Algæ in the Bay of Biscay, by M. C.

Sauvageau.—On some Devonian bacteria, by M. B. Renault. Two species of micrococcus are described, found on fossil vegetation of the Devonian age. These are the earliest known bacteria.—On the photography of the retina, by M. Th. Guilloz. —Influence of the liver on the anti-coagulating action of peptone, by MM. E. Gley and V. Pachon.

Berlin.

Meteorological Society, May 5.—Prof. Börnstein, President, in the chair.—Dr. Carl Müller spoke on the adaptation of plants to climate and weather, and discussed the mechanisms by which they take up water and carbon dioxide from the air, as also the various configurations of the earth's surface which either assist, limit or regulate transpiration in dependence upon climate and weather. He further gave a sketch of the means by which radiation is limited during the night, and by which the access of light to the assimilative chlorophyll corpuscles is facilitated and regulated, as also of the multitudinous arrangements for the avoidance of the deleterious action of heavy rain and violent winds.

Physiological Society, May 8.—Prof. du Bois Reymond, President, in the chair.—Dr. Cohnstein discussed certain recent papers dealing with the theory of lymph formation which oppose Heidenhain's view that it is the result of a secretory process, and tend to prove that diffusion and osmosis suffice entirely to explain the passage of the constituents of lymph through the walls of the capillaries.—Prof. I. Munk spoke on muscular work and proteid metabolism, and combated Chauveau's most recent views that the necessary energy is supplied by the oxidation of carbohydrate rather than of proteid material.

Physical Society, May 15.—Prof. du Bois Reymond, President, in the chair.—Prof. Warburg spoke on the action of light on sparking discharge, and demonstrated Hertz's earliest experiments on the influence of ultra-violet rays on the striking distance of the sparks, and on the discharge of negatively electrified bodies. He next showed Hallwach's experiments dealing with spark discharge in light, and finally his own, by which he proved that the action of ultra-violet rays consists in doing away with the retardation which, according to Jaumann's researches, exists at each discharge. This retardation, which is a forerunner of the discharge, and during which some as yet unknown events take place in the path of the spark, is lessened or even completely done away with by the action of light. He conjectured that gases, unlike electrolytes and metals whose conductivity is independent of strength of current, only become conductors when the current has reached a certain intensity. Hence possibly during the retardation the gas is becoming a conductor, and if so the action of light consists in the removal of some obstruction to the establishment of conduction.—Prof. Paalzow gave an obituary notice of the recently deceased member of the Society, Dr. Haensch.

Philadelphia.

Academy of Natural Sciences, May 5.—Dr. F. P. Henry made a communication on *Filaria sanguinis hominis nocturna*, specimens of which had been obtained from the blood of a patient suffering from chyluria due to clogging of the lymphatics by the ova of the parasite. The various forms of the worm, with their life-history, as given by Dr. Patrick Manson, were dwelt on.

May 12.—Dr. Charles S. Dolley described a centrifugal apparatus, which he called a Planktonokrit, for the quantitative determination of the food supply of oysters and other aquatic animals. By means of its use he is enabled to make a large number of plankton estimates in a day, and thus judge of the characters of given areas of water in connection with fish and oyster culture at different times of the day, states of the tide, varying depths, &c. The method employed is that of the centrifuge, an apparatus which consists of a series of geared wheels driven by hand or belt, and so arranged as to cause an upright shaft to revolve up to a speed of 8000 revolutions per minute, corresponding to fifty revolutions per minute of the crank or pulley-wheel. To this upright shaft is fastened an attachment by means of which two funnel-shaped receptacles of one litre capacity each may be secured and made to revolve with the shaft. The main portion of each of these receptacles is constructed of spun copper, tinned. When caused to revolve for one or two minutes the entire contents of suspended matter in the contained water is thrown to the bottom of tubes properly placed, from which the amount may be read off by means of a graduated scale.

BOOKS, PAMPHLET, and SERIALS RECEIVED.

Books.—Cosmic Ethics; or, the Mathematical Theory of Evolution: W. C. Thomas (Smith, Elder).—Modern Optical Instruments: H. Orford (Whittaker).—Engineer Draughtsmen's Work (Whittaker).—Azimuth Tables for the Higher Declinations: H. B. Goodwin (Longmans).—Latitude and Longitude: W. J. Millar (Griffin).—Sporozoenkunde: Dr. von Wasielewski (Jena, Fischer).—Elementarcurs der Zootomie in Fünfzehn Vorlesungen: Drs. B. Hatschek and C. J. Cori (Jena, Fischer).—Apollonius of Perga, Treatise on Conic Sections: edited in Modern Notation by T. L. Heath (Cambridge University Press).—An Introductory Treatise on the Lunar Theory: Prof. E. W. Brown (Cambridge University Press).

Pamphlet.—Staten Island Names: W. T. Davis (New Brighton, New York).

Serials.—L'Anthropologie, tome 7, No. 2 (Paris, Masson).—Botanische Jahrbücher, &c., Einundzwanzigster Band, v. Heft (Leipzig, Engelmann).—Sitzungsberichte der K. B. Gesellschaft der Wissenschaften Math. Naturw. Classe, 1895, i. and ii. (Prag).—Century Illustrated Magazine, June (Macmillan).—History of Mankind: F. Ratzel, translated, Part 9 (Macmillan).—Bulletin from the Laboratories of Natural History of the State University of Iowa, Vol. 3, No. 4 (Iowa).—Brain, Part 73 (Macmillan).—Humanitarian, June (Hutchinson).—National Review, June (Arnold).—Contemporary Review, June (Isbister).—Scribner's Magazine, June (Low).—Journal of the Anthropological Institute, May (K. Paul).—Bachelor of Arts, May (New York).—Zeitschrift für Physikalische Chemie, xx. Band, 1 Heft (Leipzig, Engelmann).

CONTENTS.

THURSDAY, JUNE 11, 1896.

ON BEHALF OF SELECTION.

Ueber Germinal-Selection; eine Quelle bestimmt gerichteter Variation. Von August Weismann. Pp. xi + 79. (Jena: Gustav Fischer, 1896.)

THE special purpose of the present treatise, the substance of which was given as an address at the International Congress of Zoologists at Leyden in 1895, is stated by the author to be the rehabilitation of the principle of selection. This principle, though many writers now seek to minimise or to dispense with it, still appears to him to be absolutely necessary for any scientific explanation of the problem of life. The only alternative would be to allow the existence of teleological contrivances, and this in science is inadmissible. The theory of natural selection, says Prof. Weismann, has been rated too highly, and is now suffering the effects of an inevitable reaction. It has not been overrated in the sense of having been credited with too wide a sphere of action, but in the sense that investigators have believed that they understood its whole method of operation, and had a clear conception of all its factors. This, however, is not the case. It has been generally left out of account that besides the individual or personal selection recognised by Darwin, there is a selective process always at work between the various parts of the individual organism (Roux), and even between the ultimate vital units within the germ itself. This conception had already been partly propounded by the author in his Romanes lecture delivered at Oxford in 1894, and in his last rejoinder to Herbert Spencer;[1] it is here stated with greater completeness, and brought into more intimate relation with the doctrine of selection as commonly understood. By its means he claims to have advanced a more satisfactory explanation of the origin of variations and their direction along appropriate lines of development than any as yet proposed.

It is quite impossible to do justice to the view here stated within the limits of a short notice such as this. Those interested in the evolution controversy must be referred to the treatise itself, where they will find the author's position fully explained and illustrated, and from which they will also be able to judge for themselves how far his new conclusions are borne out by the facts and reasoning at his command. The main heads of the argument may, however, be briefly sketched as follows.

The laws of variation provide the stones for the building, which are laid in place by selection. Our knowledge of the selection-value of variations is necessarily limited; we are able, however, to adduce many cases of transformation that can only be accounted for on principles of utility. One such instance is the distribution of colour in butterflies as between upper and under surface, and fore and hind wing. For example, while the upper side of *Protogonius* resembles a *Heliconius*, the under side is like a leaf; this *must* be a consequence of adaptation. So, too, must be the correspondence of the hind wing with the apex of the fore wing on the under surface of many butterflies. In view of the fact that the wing-areas so coloured accord with the usual posture of each species during rest, it is absurd to talk here of simple "correlation." Can mere "laws of development" account for the fact that all leaf-like butterflies are wood-haunting species? The case of *Kallima* by itself is decisive for adaptation.

But how have the suitable variations, which have culminated in such perfect adjustment to needs, originated in the right situations, and in correlation with the appropriate instincts? Herbert Spencer applies Lamarckian principles to the explanation of functional adjustments; but this will not meet the case of such parts as are purely passive in function. The current conception of selection (*i.e. individual* selection) is also inadequate to explain instances of this nature. The root of the process must lie deeper; the variations in question must be *determined in the germ*. This is also shown by the dwindling of disused organs, which disappear in a manner not to be explained by individual selection. Lamarckism (*pace* Lloyd Morgan) will not serve, even as a working hypothesis; and if this be the case, there must be, as Osborn says, a hitherto unrecognised factor in transformation; *i.e.* the direction taken by the variation of a part must be determined by utility. Known facts, as for instance those of artificial selection, will carry us a certain distance towards an explanation. In such a case as that of the long-tailed poultry of Japan, the variation must have been enhanced by selection, and the germ itself must have undergone progressive alteration. For further steps we must have recourse to hypothesis. Variations oscillate about a mean, and selection raises the mean to a higher point. This is satisfactorily accounted for by the theory of "determinants." The determinants are subject to the same conditions of nutrition as body-constituents of a higher degree, and will accordingly differ in size and strength. Hence the opportunity for the progressive raising of the mean by individual selection. But a more important principle is yet to be introduced. The phenomena of retrogression in a disused part show that, as the advocates of Lamarckism have rightly alleged, the simple raising or lowering of the mean by "personal" selection is not adequate to explain the facts. Panmixia will account for the degeneration of such a part up to a certain point, but not for a gradual and continued dwindling ending in complete disappearance.

The really efficient cause is *germinal selection*. This rests on Roux's conception of the "struggle of parts," a principle which must apply to the most minute units of life, not only in the somatic, but also in the germ cells; not, however, of course to "molecules" in the chemical sense. Panmixia starts the determinants of a dwindling organ on the inclined plane, down which they are impelled by intra-germinal selection to their final disappearance. The progressive increase, no less than the decrease of a part, must also be assisted by a like selective process taking place within the germ.

But it is necessary to show how simultaneous useful variations arise under the law of selection. This follows from the fact that the alterations of determinants in the germ, when they are once set going by individual selection, continue without needing the help of that

[1] "Neue Gedanken zur Vererbungsfrage." Jena, 1895. "Heredity once more," *Contemporary Review*, September, 1895.

principle as directed to one definite character alone. Individual selection must, however, step in from time to time, to check the other process when this latter exceeds the demands of utility. This is how so many different modifications can be set going at the same time. It is to be observed that qualitative no less than quantitative modification must be under the influence of the same principle. Selection must affect the "biophors" as much as the "determinants" which they compose. A *quantitative* alteration of constituent biophors appears to us as a *qualitative* modification of the corresponding determinants, and this enables us to understand how "units of variation" may play their part by either simultaneous or independent modification, as on the under side of a butterfly's hind wing. The phenomena of mimicry cannot be accounted for by accidental variations only, but must depend on variation definitely directed by utility. It is to be observed that the determinants and groups of determinants here postulated have nothing to do with Bonnet's preformation theory. The determination of the character of a developing ovum by its own constitution, instead of by the action of external forces, must be admitted by all those who do not, like O. Hertwig, confound the conditions of development with its causes.

The assumption seems inevitable that every heritable and independent variation in the soma depends on the variation of a definite part of the germ; not, as Spencer thinks, on that of *all* the units of the germ. The latter theory leads to needless complication. It is no valid objection to the determinant theory that it deals with invisible elements. The same is true of the chemical assumption of atoms and molecules. The theory justifies itself as such in that it can be used as a formula, to express, for example, the conditions of di- and poly-morphism. The "Hotspurs of biology" forget that all our knowledge is provisional. The assumption of biophors and determinants is parallel to such conceptions as "force," "atoms," and "ether-waves" in the domain of physics.

Epigenesis does not, as has been held, allow a simpler structure for the germ than the counter-theory, and germinal selection explains entirely the direction of variation by utility. It also disposes of the objection that selection cannot cause the variations with which it works. Given the numerical fluctuation of the units, selection will do the rest. Hence both the exactitude and simultaneity of useful variations, a simultaneity which may affect like parts, as in the development of eyes and limbs; or unlike, as in the production of complex mimetic patterns. The principle of selection reaches just so far as utility reaches, and translates, as we have seen, quantitative into qualitative modifications. Utility undoubtedly goes hand in hand with modification, but the dwindling of disused parts shows that the inheritance of characters actively acquired does not cover the whole ground, as the selection theory does; for how can the *disuse* of an organ affect the germ? The Lamarckians are right in pronouncing individual selection inadequate to account for the facts, and also in denying that panmixia could bring about the entire disappearance of a disused organ; they err, however, in attributing the results of Roux's "struggle of parts" to heredity.

Thus then the three stages of selection are (1) personal or individual (that of Darwin and Wallace); (2) histological, as maintained by Roux; and (3) germinal, as pointed out by Weismann. There is indeed another stage, that namely between races or stocks. Here individuals play the same part as organs in individual selection; the analogy, however, is not in all respects complete.

Everything in nature, says the author in conclusion, is purposeful; and this fact can only be accounted for by the theory of selection. What is obscure in the process is so from the imperfection of our methods, not of the principle. All kinds of knowledge ultimately resolve themselves into the hypothetical and unknowable. But doubt is the parent of progress; the veil is raised little by little; and what still remains dark in the explanation points, like the magic wand in the hands of the water-finder, to the hidden springs of truth, ready to yield themselves up to the persevering seeker.

The preface contains a forcible and dignified vindication of the use of hypothesis in scientific investigation; both generally and with special reference to the author's own theory of heredity. Appendices are added, in which several points raised by the paper receive more detailed treatment. The controversies that have centred round Prof. Weismann's former works are not likely to be hushed by the present treatise. We may safely venture to predict that the olive-branch held out to the neo-Lamarckians (p. 59) will not be accepted, though the admissions as to the inadequacy of individual selection will be welcomed by many as evidence of a change of view. The absence of all reference to amphimixis no doubt simplifies the argument greatly; it will, however, be probably used in some quarters to point the moral of the author's inconsistency. But, whatever the amount of acceptance which this latest development of the selection-hypothesis is destined to achieve, there can be no question that the present will rank among the most interesting and suggestive of the Freiburg professor's contributions to biological theory. F. A. DIXEY.

[ADDENDUM.—Since the above notice was written, an English translation of Prof. Weismann's treatise has been issued by the Open Court Publishing Company, Chicago.—F. A. D.]

RIVERSIDE LETTERS.

Riverside Letters; a continuation of "Letters to Marco." By George D. Leslie, R.A., author of "Our River." Pp. xvi + 251. (London: Macmillan and Co., Ltd., 1896.)

ALTHOUGH in his preface Mr. Leslie is careful to state that he cannot assert in the case of these Letters, as he did in the previous volume of his "Letters to Marco," that they were written wholly without view to publication, yet is there little or no change in subject-matter or in style. They are, like the former collection, genuine letters sent to his friend Mr. Marks, R.A., and the topics on which he writes are of mutual interest to the two friends who both, as he says, "love nature for her own sake, untrammelled by the prepossessions that not unfrequently accompany that love among the votaries of science or sport," and in publishing them he doubtless

hopes to find like sympathetic readers among the many who share that love with the two Royal Academicians. Nor do we think he hopes in vain. Admirers of nature are a companionable folk; they love to compare notes, to be asked to share each other's triumphs, to admire each other's finds, and among the topics on which Mr. Leslie dilates are many in which they will find an interest. They will be ready with their tribute of admiration for his *Iris susiana* and his *Cipripedium spectabile* (diverse triumphs), with their sympathetic sorrow at the loss of his old and faithful donkey, and will appreciate his avowal of the inexpressible pleasure he felt at the casual discovery of the exquisitely coloured berry of the lily of the valley. "You will, I dare say, laugh at me for my sentimentality," he writes. We cannot believe that his correspondent did, nor will the appreciative reader. It is the spirit of the true lover of nature, to whom such sights, the more that they come unexpectedly, can ever "bring thoughts that do lie too deep for tears."

Mr. Leslie confesses to a life-long fondness for gardening. He tells us that he had known the Jew's Mallow for more than fifty years before he learnt its botanical name of *Kerria japonica*. We doubt if he is happier for the knowledge. We, for our part, love to think of these old favourite flowers by their nicknames, so to speak, and not by the mongrel Latin names of the florists' catalogues. Among plants, as among men, the possession of a nickname is a sign of popularity, and it is the tender old-world associations that linger round them that give such a charm to some mere list of flowers in the poetry of the Elizabethan age. As regards the name of "Jew's Mallow," which, by the way, belongs to the rather numerous class of plants that cottagers seem to grow better than any one else, Mr. Leslie gives an explanation which is new to us, and which, though doubtless a true one, is far less interesting or suggestive than many a one which our imagination has tried to frame. While on the subject of names, surely Mr. Leslie is wrong in blaming (p. 75) English rose-growers for giving French names to the roses they introduce. In a list of more than 170 kinds we cannot find one case of such unpatriotic conduct, while such well-known instances as Captain Christy, Hon. Edith Gifford, and W. A. Richardson seem to point the other way.

The even tenor of Mr. Leslie's narrative is interrupted by two important events—the great flood of November 1894, and the long frost of the early part of 1895, from both of which visitations he escaped comparatively unscathed. In the case of the latter, he attributes his immunity to having such hardy and well-established plants in his garden; while in the former, the porous subsoil, chiefly gravel and sand, seems to have allowed the water to drain away, leaving only a little mud behind. We wonder, by the way, that Mr. Leslie found no fish stranded after the water subsided. We saw on that occasion hundreds of little ones, chiefly baby roach, left lamenting in a meadow near Marlow. But light as the visitation was, those who feel inclined to envy him the facilities to which he owes his Buck Bean and *Cipripedium spectabile*, will perhaps find some consolation in the sketch of his lawn tennis court on November 19, 1894, which, as he says, "was covered by four feet of water, and formed a lovely calm pool to boat on. I took the opportunity in my boat, of clipping the top of a hedge, which was rather too high to reach under ordinary circumstances." A quaint touch.

Like a true gardener, Mr. Leslie has his gird at the weather, anent the disastrous May frosts of two successive years, and at the devastating efforts of his paid staff, a gardener and a boy, in their attempts to help in the flower garden. In this we cordially sympathise with him. Work among the cabbages and potatoes seems to induce in the former official a breadth of handling quite inconsistent with the delicate stippling (we trust we do not misuse these technical terms) appropriate to the flower garden, while there is no weed, not even couch-grass or bindweed itself, that we would not rather see in our borders than "a boy" with a hoe.

With the many other topics touched upon by Mr. Leslie, we have here no space to deal. The book is pleasantly illustrated with drawings by the author. In the sketch of the Nuthatch, we cannot think that he is represented quite stoutly enough built. We have very frequent opportunities of seeing one at his work, and have been much struck not less with the great development of the muscles of his neck, than with the evident force with which he uses them, which latter is admirably indicated in this drawing.

To conclude, Mr. Leslie's book is not, and does not pretend to be, scientific or exhaustive, but it is eminently readable; and those whose lighter occupations lead them to find interest in the same field as Mr. Leslie, will derive much pleasure from the congenial gossip of "Riverside Letters."

MAN AND NATURE IN FINMARK.

Folk og Natur i Finmarken. By Hans Reusch, Ph.D. Pp. 176. 32 Illustrations. (Kristiania: T. O. Brögger, 1895.)

THE district treated of in this volume is one to which, at the present moment, the eyes of the astronomical world are turned with lively interest; for within its bleak borders the approaching eclipse of the sun will be observed if the atmospheric conditions be favourable. To astronomers, therefore, this book will be specially interesting and opportune; and not to them alone, but to every traveller who has visited the far north of Norway and sought the midnight sun, and even to the still more numerous class who are compelled to content themselves with acquiring a knowledge of lands and peoples solely from books. It is a model of what a book of travel should be; all insignificant details are ignored, but we have the observations and suggestions of one of the shrewdest of observers. Dr. Reusch is deeply interested in the commercial progress and social welfare of his fellow countrymen, and his book is full of valuable suggestions for the advancement of both; while at the same time he is not only just, but very generous in the views he expresses about other races, especially in regard to the Russians, whose territory forms the eastern boundary of Finmark. He describes in graphic and, at times, eloquent language the physical and geological features of the desolate interior of this northern province, which lies far within the Arctic circle, its storm-beaten coasts and its inhospitable, silent, stony deserts, where no tree will

grow, not even a shrub, and from which animal life is almost completely banished. Only in its valleys and its waters is there any abundance of animal life; and consequently its human inhabitants are confined mainly to the valleys and the coast. Finmark has a population of 18,000 Laps and 8000 Fins (the Norsk element is insignificant, being only 1 in 300); but these are actually increasing, the Laps having doubled, and the Fins more than doubled, between 1860 and 1887, in spite of the almost chronic condition of poverty in which they, especially the Laps, live, the frequent hunger from which they suffer, and the dirt which characterises their persons and miserable dwellings. They are, nevertheless, healthy as a whole, though the infant mortality is high; and, in spite of their wretched conditions, they are entirely free from those scourges of civilised life—consumption, cancer, calculus, dropsy and dysentery. The Laps are contented, honest (except as regards reindeer), unambitious, improvident and very drunken; their luxuries being brandy, coffee and tobacco. Imprisonment with bread and water is no hardship to a Lap who has been sent to the house of correction for reindeer stealing; he returns from Trondhjem with the air of a travelled man who has acquired distinction.

In discussing the question of the amelioration of the condition of the Laps, Dr. Reusch writes like a far-seeing statesman. He wishes to see them Norwegianised and civilised by the State, and by the mildest methods; he regards the school as the most effective agent, and recommends free education, free food and lodging for children far distant from their homes, and the compensation of the parents by the State for the loss of the services of the children. He admits that there may be individual cases of oppression on the part of Norwegians, which are never heard of, because the Laps cannot or do not write to the papers like the Danes in Schleswig, or the Germans in the Baltic provinces of Russia. In addition to his own observations, the author has availed himself of all trustworthy local information regarding ethnography, commerce, fisheries, industries, natural history, natural products, and mentions the Pasvig River as the only locality in Europe where diamonds are to be found. He enters very fully into the social condition of all the races in Finmark—Lap, Fin, Norwegian, and the Russian traders. The book is an exceedingly interesting one, and is well illustrated; but it is written in Norsk, a language with which, unfortunately, not many are familiar.

James C. Christie.

OUR BOOK SHELF.

Weitere Ausführungen über den Bau der Cyanophyceen und Bacterien. By Prof. O. Bütschli. (Leipzig: Wilhelm Engelmann, 1896.)

Some five years have elapsed since Prof. Bütschli first published his investigations on the structure of some of the sulphur bacteria: *Chromatium*, *Ophidomonas*, and Beggiatoa, and his views on this subject have been circulated and discussed far and wide. In the above work Prof. Butschli has restated at greater length, and at the same time more precisely, the position which he has been led to assume with regard to this delicate question. We say "delicate question," because at present an opinion one way or another can only be based upon the degree of staining dexterity possessed by the investigator, and the results obtained are directly dependent upon the skill with which such operations are manipulated, whilst their interpretation is also subject to the individual intelligence or originality of the experimenter. Prof. Butschli's own words will best express the object which he has had in view in the publication of the present pamphlet. "Although I have made no fresh investigations in this direction during the years which have elapsed since I first published my views, it has appeared advisable to me for some time past to once more express myself on this question, and to support my opinion by the publication of micro-photographs. . . . I have, therefore, studied afresh during the past winter the greater number of the preparations I made in the years 1889–90, and I can only add that although some preparations have suffered in the interval, I have found everything exactly as I described it in 1890. . . . In the following exposition, which I have put together as briefly as possible, I have principally dealt with the doubts which have been thrown at, and attacks which have been made upon, my former statements." In taking up this essay the reader is, therefore, plunged into a keen scientific controversy, and for those who are concerned one way or the other, the subject-matter is replete with interest, and the scientific *littérateur* will gratefully accept the exhaustive bibliography bearing upon the question; whilst even the layman, who possibly feels but slender interest in the problems surrounding the structural character of these lowly forms of life, cannot but admire the beautiful plates with which the text is illustrated.

A Dictionary of the Names of Minerals, including their History and Etymology. By A. H. Chester. Pp. xv. + 320. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1896.)

The study of mineral names by Prof. Chester was originally begun in the interest of Murray's New English Dictionary: the results of years of patient work and search are conveniently collected together in the volume now issued. In the case of each name a record is given of the name of its author, the year of the first publication, a reference to the work in which the name was announced, the derivation, the reason for the name, and a description of the mineral sufficient to indicate the one to which the name was intended to be applied. For many names the information has been already given in Dana's "Mineralogy"; Prof. Chester has gone to much trouble in the attempt to fill up the gaps which remain, but he gives a long list of names relative to which further information is still required. The book will be useful, not only to those who are interested in nomenclature, but to all who wish to have in a single small volume a brief statement of the chemical composition of the minerals to which names have at any time been given. It may be added that Prof. Chester appends a list of the authors of mineral names with the names for which each author is responsible.

L. F.

Principii della Teoria Matematica de Movimento dei Corpi. Gian Antonio Maggi, Professore ordinario della R. Università di Pisa. Pp. 503. (Milano: Ulrico Hoepli, 1896.)

By omitting illustrations, examples and exercises, and diagrams, the author has managed to give a very compact treatise on all the ordinary formulas of Theoretical Dynamics, including a little Hydrostatics. The author has incorporated into his treatment the most modern ideas of Clifford and Mach; his analytical treatment is elegant and condensed; but a little geometrical and pictorial treatment would give some relief to the procession of equations.

G.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Tidal Migrations of Limpets.

WHILE spending a few days, in March of this year, at the village of Matadona, situated on the south-east coast of British New Guinea, facing the China Straits and nearly opposite to the large island of Rogeia, I had the opportunity of making some observations on the habits of a species of limpets.

On the beach near Matadona there is a sort of rugged platform formed by massive eruptive rocks, extending seawards and presenting in some places a more or less vertical frontage, of some three feet in height, to the sea.

The rocky platform, covered at high tide, is quite exposed at low tide, the sea receding a considerable distance away from it.

Great numbers of limpets live on the sub-vertical front of the rocks, while the numerous small holes and crevices, with which it is riddled, are occupied by Chitons, several of which are often crowded together in a very limited space.

Several species of Patella inhabit these rocks at various points, but as a rule they occur as isolated individuals. One species, however, occurs in large herds of a hundred or so individuals, and it is to this gregarious Patella that the following notes refer.

At low tide these limpets are attached to the seaward face of the rock, quite at its base, adjoining the sand of the beach, and it may then be observed that the zone of limpets, as a general rule, occupies a lower level than that of the Chitons.

It may also be noted that many of the limpet shells are themselves coated with Nullipores and other marine plants.

I have several times observed, at the time of flood-tide, that at the approach of the surf, when the latter gets so close as to spray the rocks, the limpets commence to crawl slowly up the face of the rock, and as the tide rises higher so they climb higher, always keeping above the level of the surf.

It can often be observed that they progress in the form of a triangle, the leader at the apex.

From the time the procession commences until they reach the summit of the rocks, out of the reach of the violence of the surf, the slow movement is practically continuous, the whole company of limpets being found on close inspection to be in motion, and producing a unique effect.

The Chitons, sheltered in their nooks and crannies, undertake no such migration; so that, in general, the zone of limpets is above that of the Chitons at high tide.

When the ebb-tide sets in, the limpets start on their return journey; but I have not actually assisted at the downward procession. Between the tides they are stationary, but they produce no scar on the rocks, so that there can be no question as to their "homing" on the same spot.

On returning to the rocks on one occasion, after a stiff southeasterly breeze, I found the sand banked up to the depth of some two feet against the face of the rocks, approximately up to the level of the zone of Chitons, some of the latter being actually buried beneath the surface of the sand. Others again of the lower lying Chitons had shifted their positions in consequence of the inroad of sand.

None of the limpets were thus buried, and they occupied their usual relative position at the base of the available face of rock. The zones of limpets and Chitons then nearly coincided.

This tidal migration of limpets is interesting in comparison with the periodical phenomena in the lives of other marine organisms; while the elevation of the limpet zone through the formation of a sandbank, may perhaps suggest stratigraphical reflections. ARTHUR WILLEY.

Sydney, April 22.

Butterflies and Hybernation.

IN connection with Mr. Pidgeon's communication, under the above heading, in NATURE of April 2, respecting the probable wintering of a tortoiseshell butterfly in a bath-room, I may state that the hybernation of butterflies is of well-established occurrence in at least certain portions of South Africa, where one species in particular, namely, *Precis sesamus*, Trimen, assembles in numbers at the end of the summer season for the purpose. This very distinct dingy blue and red insect is plentifully distributed in East Griqualand and Natal, especially affecting the road-cuttings between Ixopo and the Ingeli-Zuurberg mountain chain. As remarked in Mr. Roland Trimen's monograph on South African butterflies, it likes shady places under a roadside bank or rocks in a cutting; and Colonel Bowker—an enthusiastic and renowned South African lepidopterist—is quoted as having seen them congregated under rocks and in holes of dry banks, as many as twenty-nine being captured by placing the net over them. Their dark bronzy green under-colouring renders them, when thus massed, almost inconspicuous in association with withered fern, grass, &c., and it is only by startling them that one very often becomes aware of their presence. I particularly call to mind, while on one of my botanical rambles in the Lower Umzimkulu district of East Griqualand in 1885, accompanied by a younger son of Mr. Donald Strachan, unexpectedly flushing at least fifty of these butterflies in the cold frosty season of July, in a secluded glen of the Vubugas rivulet. Upon a little searching among the scrub and bush we discovered a boulder, under which there must have been as many again, if not more. These we roused out with branchlets, some being more torpid than others; but, as we retired from the spot, they all flitted back to their trysting-place. This was at the severest time of the season, and I never doubted, after having observed the massing of this butterfly at all times during the winter, that it emerged safe and strong in the ensuing spring. A description and coloured figure are given in Mr. Trimen's work, vol. i. p. 231, pl. iv. f. 3.

Cape Town, May 20. W. TYSON.

Becquerel's Colour Photographs.

I SEE that the photographs in colour, taken by Becquerel's plan, are said to be mainly due to interference. My own observations do not confirm this statement. A photograph of the spectrum in colours can be readily taken on silver chloride on a glass plate, and be examined both by reflected and transmitted light. The colours in the two cases are identical, which is contrary to the "interference" explanation.

W. DE W. ABNEY.

Bolton Gardens South, S.W.

Cannizzaro Memorial.

SINCE my return from Italy, I have been so frequently asked by friends and admirers of Prof. Cannizzaro what form it is proposed to give to this memorial, that I wish, through your valuable medium, to make it known that it is intended to present the Professor with a medal commemorative of the occasion, and to devote the balance of the sums subscribed to the creation of a Cannizzaro prize or medal to perpetuate his memory, the details of which will be left in his hands.

LUDWIG MOND.

Röntgen Ray Experiments.

IT has been generally noticed that when focus tubes become much blackened, presumably by volatilisation and deposition upon the glass of the platinum of the anode, they cease to be effective owing to the apparent increase in their internal resistance. This is generally attributed to increase in the vacuum due to the occlusion of the residual gas by the platinum black. This may in part be the true explanation, but another is to be found in a curious phenomenon discovered by Prof. Crookes, and described in his 1891 presidential address to the Institution of Electrical Engineers. He says: "It appears that the greater the phosphorescing power of the substance surrounding the poles, so much easier does the induction spark pass. Surround the poles with Bohemian glass or Yttria—two phosphorescent non-conductors of electricity—and the induction spark passes easily: immediately I surround the terminals with a non-phosphorescent conductor" [a film of deposited silver] "the current refuses to pass." Very possibly the deposited platinum in an old or overworked focus tube has a similar effect to the silver in Prof. Crookes' experiment. I have recently had experience with a tube of special form which was much blackened,

and which appeared to have an enormous internal resistance, though its blue appearance and other indications pointed to rather a low vacuum, which seems to show that this is the case.

A. A. C. SWINTON.

66 Victoria Street, S.W., June 8.

Dalton's Atomic Theory.

WITH reference to the communications from the authors and from the reviewer of the "New View of the Origin of Dalton's Atomic Theory," published in NATURE for May 14, I beg leave to offer the following remarks. The most serious difficulty which the reviewer advances against the new view, seems to be that Dalton, in his manuscript lecture to the Royal Institution in 1810, states that, as a consequence of an idea respecting elastic fluids which occurred to him in 1805, "it became an object to determine the relative *sizes* and *weights*, together with the relative *number* of atoms in a given volume"; whereas in one of his note-books, under date September 6, 1803, a table of atomic weights is given. The reviewer says:—"The authors notice this conflict of statement, but get rid of it by assuming 1805 to be a clerical error for 1803." In regard to these conflicting dates, I beg to draw attention to a passage which appears to have escaped the vigilance both of the authors and of the reviewer, and which seems to tell strongly in favour of the clerical error theory. In the preface to Part I. of Dalton's "New System of Chemical Philosophy" (1808), the author, writing of himself, says:—"In 1803, he was gradually led to those primary laws, which seem to obtain in regard to heat, and to chemical combinations, and which it is the object of the present work to exhibit and elucidate. A brief outline of them was first publicly given the ensuing winter in a course of lectures on natural philosophy, at the Royal Institution in London, and was left for publication in the journals of the Institution; but he is not informed whether that was done." I do not think there is any room for reasonable doubt that this passage refers, amongst other things, to the same idea as that stated in the manuscript lecture to have occurred to Dalton in 1805. In any case the date 1803 is definitely settled by the sentence referring to the lectures at the Royal Institution, since we know that Dalton's lectures were begun there on December 22, 1803 (compare Roscoe and Harden's "New View, &c.," p. 61). It ought to be possible to place this matter beyond all doubt if the notes stated by Dalton to have been left for publication in the journals of the Royal Institution are forthcoming.

LEONARD DOBBIN.

University of Edinburgh, May 15.

Halley's Chart of Magnetic Declinations.

I AM again able to add another reference to the list of publications of Halley's Chart of Magnetic Declinations (see NATURE, vol. lii. pp. 79, 106, 343).

The chart to which I now refer is one of the plates of Peter van Musschenbroek's work, entitled "Physicae Experimentales et Geometricae de Magnete, Tuborum Capillarium Vitreorumque Speculorum Attractione, Magnitudine Terrae, Coliaerentia Corporum Firmorum"; Lugundi Batavorum, MDCCXXIX. Its size is $19\frac{1}{8}$ inches × $7\frac{3}{4}$ inches, and it takes in the entire circumference of the globe. The title, in the upper left-hand corner, reads: "Tabula Totius Orbis Terrarum Exhibens Declinationes Magneticas, ad Annum 1700. Composita ab Edmundo Halleyo. Simul eum Inclinationibus a Poundio Observatis."

CHAS. L. CLARKE.

New York, May 28.

Professional Qualifications.

I AM anxious to prepare myself for the appointment of professor or teacher in chemistry at one of the new technical schools held under the County Councils. Will you kindly inform me the best way to become competent for the post? My age is twenty-five, and I hold first-class certificates in advanced chemistry at South Kensington Science and Art examinations. Is it necessary to obtain the F.I.C. or some similar degree first? Any hints you could give me would be of great help to me.

I must add that at present I have had no experience in teaching.

STUDENT.

LEAP-YEARS AND THEIR OCCASIONAL OMISSION.

AFTER the present year there will be no leap-year, at any rate, in the many countries which now observe the Gregorian style, until 1904; in other words 1900, which would, by the Julian rule, have been a leap-year, will be a common year and have to content itself, like the three years preceding and the three years following it, with the ordinary number of three hundred and sixty-five days. Only once has a similar omission occurred before since the reformation of the calendar in England, viz. in 1800, a year remarkable enough in other respects. The change was originally made in 1582; but as centuries divisible by four hundred without remainder were to be considered leap or bissextile years by either reckoning, there was only occasion, in 1700, when a year was observed as such in England, which was a common year in southern Europe; for 1600 was, as 2000 will be, a leap-year by the Gregorian as well as by the Julian reckoning. Few persons seem to recollect that the change which was effected at Rome in 1582, and followed in this country in 1752, was twofold in its character. If it be desired to make the date in any year correspond exactly with the season of the year, this can of course be done for any future time by inserting or omitting certain intercalary days in the calendar in some such way as is directed by the Gregorian rule to which we are now accustomed, and which was devised by Clavius under the authority of Pope Gregory XIII. But if this had not been done in past ages through want of exact knowledge of the true length of the year, or from any other cause, the fact may either be accepted as inevitable and therefore regretfully disregarded, or we may, if we wish, so change the existing dates in the year from which we start, as to make the seasons correspond with what they were on these dates at some definite period in the past. This is what was actually done, the period selected being A.D. 325, the year of the first great Council of the Church held at Nicæa in the reign of Constantine the Great. At that time the vernal equinox fell on March 21; and as, in consequence of the observance of the Julian length of the year in the interim, it fell in 1582 on the 11th of that month, it was decreed that in the following autumn ten days should be struck out of the calendar, by calling the day after October 4 the 15th, so that in future the vernal equinox (and all the other seasons) should fall as they had done in 325. This arrangement involved another inconvenience besides the awkward enumeration of days in that year, viz. that the seasons were made to disagree appreciably with their dates in the years and centuries immediately preceding the time of the change. However, on the whole, it was thought to be the best arrangement, and it was gradually followed by most of the nations of Europe excepting Russia. In England the change was made in 1752, and the calendar in all respects assimilated to that of the New Style, adopting the Gregorian rules. As in accordance with these, 1700 had not been a leap-year, whereas in England by the Julian reckoning it had been, the two calendars now differed by eleven days; the Act of Parliament therefore, which ordered the change, enacted that the day after September 2, 1752, should be called the 14th.

In speaking of the erroneous length of the year assumed in the Julian calendar, we used the expression "through want of knowledge of the true length of the year, or from any other cause." This was intended as a reference to the fact that, although the exact length of the year was not known in the time of Julius Cæsar, it was certainly known that it fell several minutes short of $365\frac{1}{4}$ days. But it seems that he thought this was sufficiently near for all practical purposes; and a distinguished American astronomer of our own day, in the light of all our modern improved knowledge, is of that

opinion. "The change of calendar," says Prof. Newcomb, "met with much popular opposition, and it may hereafter be conceded that in this instance the common sense of the people was more nearly right than the wisdom of the learned. An additional complication was introduced into the reckoning of time without any other real object than that of making Easter come at the right time. As the end of the century approaches, the question of making 1900 a leap-year as usual, will no doubt be discussed, and it is possible that some concerted action may be taken on the part of leading nations looking to a return to the old mode of reckoning."[1] We are now several years nearer that time than when these words were written, but there is no proposition to return to the Julian reckoning, whilst it seems likely that Russia, which still observes it, will shortly adopt, either at once or by degrees, the Gregorian style, in which case all Christian nations will conform to its use. But it should never be forgotten that Cæsar's main object was to get rid of the previous Roman complication between a solar and a lunar year (endeavouring to keep them together by the insertion from time to time of an intercalary month), and substitute an entirely solar year with only an intercalary day every fourth year, making the length equal to its true amount within a few minutes.

But now comes the question, Is the so-called Gregorian year absolutely exact? Its length is unquestionably nearer that of the true typical year than the Julian year is. But a further modification is necessary if we really desire to make the date of the year correspond with the seasons for all time. The Gregorian rule amounts in fact to considering the year to contain 365·24250 days, whereas the typical year really consists of 365·24220 days, the difference being 0·00030 day, and the Gregorian year is too long by that amount. It in fact drops a leap-year not quite often enough, and a better rule would have been to drop one at the end of each successive period of 128 years. M. Auric has therefore recently suggested in the *Comptes rendus* of the French Academy a modification of the Gregorian rule, which would render it almost absolutely accurate, but which this generation need not, and in fact cannot, decide upon adopting. In 3200 years there are twenty-five periods of 128 years, so that there should be twenty-five omissions of leap-years. But by the Gregorian rule, only twenty-four leap-years are dropped in that interval, or one too few. His proposition then is to make an additional drop or omission of a leap-year in the year 3200 (which would, as the Gregorian rule now stands, be a leap-year), and at every succeeding period of 3200 years, A.D. 6400, 9600, being *not* leap-years. Strictly speaking, however, as the Gregorian calendar was arranged to start from A.D. 325, the first of these periods should expire more than three centuries later than A.D. 3200, and as A.D. 3500 will not be a leap-year by the Gregorian rule of dropping all divisible by 100 without remainder unless also divisible by 400, the nearest way to carry this proposal out practically would be to enact that A.D. 3600 should be an exception and not a leap-year; M. Auric's rule being afterwards applied at intervals of 3200 years, so that A.D. 6800 and A.D. 10000 would not be leap-years, although the Gregorian rule would make them so.

The present writer ventures to propound his own view that this same object would be carried out more straightforwardly by the natural course of dropping a leap-year at the end of each period of 128 years as it was completed, making unnecessary the Gregorian complication of an exception of an exception (*i.e.* the usual leap-year) now proposed to be increased by an exception of an exception of an exception. How exact this one exception would make the calendar (and M. Auric's suggestion would do precisely the same thing in a more roundabout way) may easily be shown. By dropping a leap-year (which usually occurs every fourth year) at the end of 128 years, we obtain in that period ninety-seven common years of 365 days, and thirty-one bissextile years of 366 days, or 46,751 days in all. Dividing this by 128, it is seen that this is equivalent to making each year contain 365·24219 days, the true length of the tropical year being (as above stated) 365·24220 days. It is agreed on all hands that 1900 is not to be a leap-year; and the effect of acting on this proposal would be that the next omission of a leap-year after that date would be in A.D. 2028.

W. T. LYNN.

[1] What Prof. Newcomb means here is making the vernal equinox which the paschal full moon followed, fall on the same date as it did at the time of the Nicæan council.

THE NICARAGUA CANAL.[1]

THE author of this book, though originally an engineer by profession, has become a traveller, a newspaper correspondent in Africa, the Far East, and Central America, and a writer about Eastern countries and problems. The book, accordingly, somewhat naturally reflects the two-fold experiences of the writer. Nicaragua is regarded, on the one hand, as the probable site of a gigantic engineering undertaking for connecting the Atlantic and Pacific, rivalling in commercial importance the Suez Canal; and the feasibility and prospects of the proposed canal are considered from an engineering standpoint, in combination with its commercial and political aspects, which cannot be disassociated from the more purely engineering problems involved. On the other hand, Nicaragua is described, in four chapters in the middle of the book, from the traveller's point of view; and details are given of the manners and customs of the population, the means of communication and resources of the country, with descriptions of the principal towns and other matters of interest noticed in the author's tour through the country. This portion of the book will possess attractions for readers of books of travel; but it appears to have been introduced rather with the object of recording the facts casually collected by the author, than as having any special bearing on the important problem of interoceanic communication. The main object of the book is unquestionably the Nicaragua Canal; and the Suez Canal has demonstrated that it is quite possible to construct a highway for navigation in a country devoid of natural resources, and that the physical conditions of the site selected, and the climate, are the main points which determine the feasibility of isthmian canals.

Several routes have been proposed for forming a water-way across the isthmus of Panama; but the only two which have been deemed capable of practical adoption are the line chosen for the Panama Canal, traversing a narrow portion of the isthmus between Colon and Panama, nearly following the course of the Panama Railway, and the more northerly Nicaragua route crossing a much wider part of the isthmus, in which, however, Lake Nicaragua provides a considerable length of natural water-way. The Paris Commission of 1879, presided over by M. de Lesseps, decided in favour of the Panama route in preference to all the others, including Nicaragua, mainly on the ground that it was essential that an inter-oceanic canal, with prospects of a very large traffic, should be an open water-way unimpeded by locks, like the Suez Canal; and Panama was the only route which could possibly fulfil this condition. When, however, owing to the treacherous nature of the soil under a tropical rainfall, the unhealthiness of the site when the surface vegetation was disturbed by the excavations, and the difficulties experienced in attempting to cope with the floods of the river Chagres, whose course frequently

[1] "The Key of the Pacific, the Nicaragua Canal." By A. R. Colquhoun. Pp. xiii + 443, with numerous illustrations, plans, and maps. (London: Archibald Constable and Co., 1895.)

crosses the line of the canal, it became imperative to introduce locks on the Panama Canal, in order to endeavour to complete the canal within a reasonable time and at a practicable cost, the special advantage of the Panama route disappeared. During the progress of the Panama Canal works, the Nicaragua scheme naturally remained

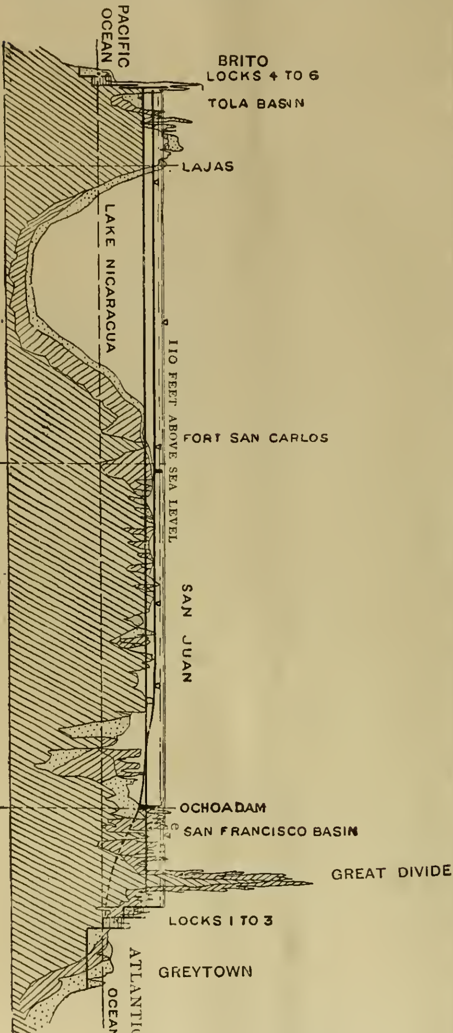


FIG. 1.—Nicaragua Canal (longitudinal section).

in abeyance; but when the works at Panama came to a standstill for want of funds in 1889, and discredit fell upon the promoters, interest was again aroused in the Nicaragua Canal as the only alternative method of connecting the Atlantic and Pacific. The two routes across the isthmus, starting from points 280 miles apart on the Atlantic side, present a remarkable contrast in their natural configuration. The Panama route, starting from Colon in the Bay of Limon on the Atlantic side, and terminating near Panama in the Bay of Panama on the Pacific coast, has a length of $46\frac{1}{3}$ miles; and the ground rises on the Atlantic side with a fairly gentle slope to the central Culebra ridge, reaching a maximum elevation of about 317 feet above sea-level, and descends with a steeper slope to the Pacific. The canal, as originally designed, had to be formed in cutting throughout; and a considerable portion of the excavations had been accomplished along the 27 miles of lower ground at the two ends before the cessation of the works, but comparatively little progress had been made in cutting through the main central ridge, 19 miles in width. The introduction of five locks on each slope has very greatly reduced the amount of excavation for carrying the canal through the central high ground; but it has been estimated that nearly forty million cubic yards of excavation still remain to be effected, and that an expenditure of £36,000,000 is required for the completion of the canal with locks.

The Nicaragua Canal is designed to start from Greytown on the Atlantic side; and after traversing about twelve miles of low marshy land, it is to rise by three locks to its summit-level (Fig. 1). This summit-level is to consist of dammed-up waters of the Deseado, San Francisco, and San Juan rivers on the Atlantic slope, Lake Nicaragua, from which the San Juan River issues, and the Tola basin formed by damming-up the waters of the Tola and Grande rivers on the Pacific slope. The canal is to descend by three locks from the Tola basin to the harbour which is to be constructed at Brito, by two converging breakwaters, at the Pacific end of the canal. The peculiar feature of the Nicaragua Canal is the long summit-level provided, about 110 feet above mean sea-level, by damming-up the rivers on each slope, in addition to the natural water-way across the lake, thereby greatly diminishing the excavation for forming a canal with a total length of $169\frac{1}{2}$ miles between the two oceans, and substituting free navigation along $142\frac{1}{2}$ miles of the route, in place of the restricted navigation of a narrow canal (Fig. 2). In spite, however, of the engineering skill exhibited in adapting the design so as to take advantage of the special physical conditions of the site, two high ridges have to be pierced near the two extremities of the summit-level, known respectively as the Eastern and Western Divides, involving, in the case of the Eastern Divide, a maximum depth of cutting of 328 feet, equalling in depth the Culebra cutting originally contemplated for a tide-level canal at Panama, through strata apparently not very dissimilar to the Culebra cutting, and exposed, as in that case, to an exceptionally heavy tropical rainfall and a very unhealthy climate. In addition to these unusually deep and formidable cuttings, a considerable amount of dredging will be necessary along the upper part of the San Juan River, to procure the requisite depth of 28 feet, together with the removal of rock from its channel at its exit from the lake and across some rapids in its course. The formation of the canal across the low-lying land between Greytown and the locks on the eastern slope, presents no engineering difficulty; but the provision of a deep-water entrance between this portion of the canal and the Atlantic, and its maintenance, constitutes one of the most difficult problems of the undertaking. Greytown, the only place along that part of the coast, for a long distance, where deep water approaches the shore, is situated upon a lagoon which has gradually formed in front of the port, by the advance of the delta of the river San Juan under the influence of the waves raised by south-easterly winds; and it is proposed to carry a breakwater out from the shore into deep water to arrest the littoral drift, under the shelter of which an approach channel is to be dredged. A dam,

composed of a mound of loose rubble stone, is designed to be formed across the San Juan River at Ochoa, below the confluence of the river San Carlos, 44½ miles from the lake, in order to raise the water-level of the river to that of the lake along this distance, amounting to an elevation of 56 feet at the site of the dam; but, considering that it is proposed to place this dam on the unstable sandy bed of the river, and that the floods of the river will pass over its crest, the design has not been given adequate solidity. The dam at La Flor, for the Tola basin on the Pacific coast, is to be given a masonry core; and dams will have to be formed for retaining the water in the San Francisco and Deseado valleys; and upon the security of these dams, and the provision for the discharge of the surplus water of the rivers, will depend the safety of the canal. Mr. Menocal, the engineer of the Nicaragua Canal, estimated the cost of the works originally at £13,000,000; but, after revising the estimates, and making allowance for contingencies, the capital has been fixed at £20,000,000; though on this point Mr. Colquhoun remarks that, "taking into consideration all the circumstances—especially the climate, its debilitating character generally, and the excessive rainfall on the eastern side, the volcanic question, the difficulties as regards labour —I am inclined to think that £30,000,000 in genuine expenditure on the work will be found nearer the mark than the present estimate."

The sites of the two rival schemes for piercing the isthmus of Panama, though differing greatly in their general configuration, are very similar in respect of unhealthiness and excessive rainfall on the Atlantic slope and the nature of the strata to be traversed by the excavations; whilst, though a greater height has been adopted for the summit-level for the Panama Canal with locks, necessitating a larger number of locks than for the Nicaragua Canal, the excavation for the Panama Canal has been reduced considerably below the amount required at Nicaragua, and the maximum depth of the Culebra cutting is now about 150 feet less than that of the cutting through the Eastern Divide. The Panama scheme has a greater length of restricted water-way; but this will be compensated for by the much shorter length of the canal, and by the proposed damming-up of the river Chagres, providing free navigation along one or two of the reaches, as well as controlling its floods. The chief difficulty in the construction of the Panama Canal, as now designed, consists in the control of the discharge of the torrential Chagres, which has, however, been greatly minimised by the introduction of locks; whilst not less difficult problems confront the promoters of the Nicaragua Canal, in ensuring the stability of the dams for raising the water-level, the control of the floods of the rivers impounded to form the water-way, and the formation and maintenance of a deep-water entrance through the advancing sands encumbering the approach to Greytown. Nicaragua, moreover, is much nearer the zone of volcanic disturbances than Panama; and severe shocks from this cause would be fatal to the stability of the dams. The estimated cost of completing the Panama Canal is indeed greater than the highest estimate quoted for the Nicaragua Canal, and more searching investigations of the site are in progress, which may possibly lead to an increase in the estimates; but, on the other hand, the recent very adverse report of the United States Commission on the Nicaragua Canal, both as regards construction and cost, shows that no reliance can be placed on the estimates hitherto presented, and that the designs of the dams and other important works will have to be entirely remodelled. A considerable amount of interesting information about the Nicaragua Canal, and its prospects and probable influence on trade, is given in the first five and two last chapters out of the fourteen contained in the book, the description of the project being naturally largely derived from the reports by Mr. Menocal, the originator of the scheme, often in the very words of the promoter. In comparing, however, the Nicaragua Canal with the Panama Canal, it is evident that Mr. Colquhoun adopts the part of an interested advocate instead of an impartial critic. Thus, after alluding to the main points of the Panama Canal and

FIG. 2.—Nicaragua Canal.

Tehuantepec Ship Railway, he concludes the first chapter with the statement, that—

"The greatest obstacles met with in other localities are: (1) high elevations in the Cordillera separating the two oceans, requiring tunnelling; or (2) a high summit-

level requiring a large number of locks, for which an adequate water-supply is not obtainable; or (3) torrential streams whose control within economical limits defies the skill of the engineer."

"Nicaragua is free from all these obstacles."

It would naturally be supposed that Mr. Colquhoun was summing up the views he had arrived at after due deliberation; but in reality he is only acting as the mouthpiece of Mr. Menocal, for the statement is taken verbatim from this engineer's paper on "The Nicaragua Canal," read before the Water Commerce Congress of Chicago in 1893. Summing up the results of his visit to the Panama Canal, the author says:

"The general impression I gained from my visit was that a large amount of useful work remained accomplished. Still the Chagres river and the Culebra cut appeared to me to be obstacles which may be considered insurmountable"; whereas, in reference to the Nicaragua Canal, he says: "The only serious difficulties are (*a*) the Ochoa dam, (*b*) the Great Divide, (*c*) the Greytown Harbour, none of them, however, insurmountable."

In fact, Mr. Colquhoun exhibits a disposition to minimise the obstacles to the construction of the Nicaragua Canal, and to exaggerate those of the Panama Canal, which occasionally leads him to make contradictory statements in different parts of the book. Thus on p. 116, he says:

"While the lake region and Pacific slope are healthy and superior to Panama, the country embraced between Ochoa and Greytown, in my opinion, presents much the same climatic difficulties. Here occurs the dredging of the channel through the stagnant swamps of the San Juan delta, as well as the cut in the 'Great Divide' and the Deseado and San Francisco basins through dense tropical jungle with a rich (but rotten) surface soil. The past history of the Panama Canal and Panama Railway, with their enormous expenditures of life, makes it imperative to treat very seriously this question, and to take every possible precaution. The climates of both Colon and Panama have greatly improved since the canal days."

Later on, however, in contrasting the two schemes on page 142, he remarks:

"The advantages over Panama are these:—It is a fresh-water canal, with an admirable natural reservoir—the lake; it passes through a region offering prospects of great development, free from the marshy soil, the overpowering heat, and the unhealthy climate of Panama; there is no Chagres River problem, and the 'Divide' stands in a different category to that of the Culebra at Panama."

Again on page 317, he states:

"The Panama isthmus, in addition to being very unhealthy, is a region of floods with very poor local resources; the Suez Canal runs through a sandy desert. Nicaragua stands in marked contrast to both these projects. It has a climate immensely superior to that of Panama, a fertile soil, and internal intercommunication, with great resources both vegetable and mineral."

It may be observed, with regard to these last two extracts, that the Panama Canal with locks would be a fresh-water canal, amply supplied by the Chagres, Obispo, and other rivers; it is curious to call the Suez Canal a project; and the desert traversed by the Suez Canal has proved no bar to its unprecedented financial success.

In justice to English engineers, we must draw attention to a misstatement made by the author on page 138, where he says, with regard to the Suez Canal: "The report of other engineers was equally unfavourable." If Mr. Colquhoun had referred to the report he alludes to, he would have found that the Commission which reported was an international one, that the report was eminently favourable and formed the basis of the subsequent canal works, and that, in addition to the foreign members, three English engineers signed the report.

The Nicaragua Canal has naturally been preferred by the United States, as being nearer, and therefore more convenient for the trade of North America; and we agree with Mr. Colquhoun in considering that the simplest solution of the difficulty of connecting the Atlantic and Pacific Oceans, would be for the Government of the United States to construct the canal, which would be of incalculable benefit to the trade of that country. If, however, the United States is deterred from embarking upon this work by the very unfavourable report of the Government Commission, there appear to be no insuperable obstacles to the completion of the Panama Canal with locks, provided the necessary capital can be raised in France and elsewhere.

IN THE HEART OF A CONTINENT.[1]

THE small size of this record of ten years' travel is in keeping with the character of the author, as revealed in his pages. It is rare to meet a man so simple, brave, and kind-hearted as Captain Younghusband, and rarer still to find a book of travel so straightforward, concise, and modest as this. Many volumes have been written by travellers who have spent fewer months than Captain Younghusband has spent years in Central Asia, and without them it would perhaps have been difficult for us to estimate the magnitude of the difficulties, the overcoming of which the author so quietly relates. But this book differs from those by an entire absence of "padding," of hearsay statements, and of rash speculation. There are chapters indeed which are not purely descriptive, dealing in fact with the opinions formed and the thoughts suggested by ten years largely spent in the most remote and desolate regions of the earth. These thoughts and opinions are perhaps the most striking part of the book, showing in a remarkable manner the power of travel and the contemplation (rather than the study) of nature in educating an appreciative mind. To read the following extract from the five chapters of "Impressions of Travel," one would hardly suspect the author of being a young soldier:—

"No one, indeed, who has been alone with nature in her purest aspects, and seen her in so many different forms, can help pondering over her meanings, and though, in the strain and stress of travel, her deepest messages may not have reached my ear, now, in the after-calm, when I have all the varied scenes as vividly before me as on the day I saw them, and have, moreover, leisure to appreciate them and feel their fullest influence, I can realise something of her grandeur, the mighty scale on which she works, and the infinite beauty of all she does. These impressions, as I stand now at the close of my narrative, with the many scenes which the writing of it has brought back to my mind full before my eyes, crowd upon me, and I long to be able to record them as clearly as I feel them, for the benefit of those who have not had the leisure or the opportunity to visit the jealously-guarded regions of the earth, where nature reveals herself most clearly."

It is rare now-a-days to have the magnitude of the earth, the vastness of distances intervening between places, the month-long silence of desert and mountain forcibly brought before one, and it is startling to reflect how little the resources of modern applied science have done to facilitate journeys in really remote regions. Except for some articles of food and the means of defence, men must travel in Central Asia now just as they travelled in the days of Marco Polo, or even of Alexander.

A sketch of those journeys which have won for Captain Younghusband the gold medal of the Royal Geographical

[1] "The Heart of a Continent." A narrative of travels in Manchuria, across the Gobi Desert through the Himalayas, the Pamirs, and Chitral, 1884-1894. By Captain Frank E. Younghusband, C.I.E. (London: John Murray, 1896.)

Society, will prepare the reader for considering the opinions he was led to form on some important questions regarding men and things. In 1884, at the age of twenty-one, Younghusband was invited by Mr. James to accompany him into Manchuria. Never was invitation more eagerly accepted, and once released of his military duties in India, he threw his whole being into travel. Starting from Newchwang on the Yellow Sea, they pushed northward, visiting the Ever-white Mountain, and describing for the first time the wonderful crater lake on its summit, 8000 feet above the sea, whence flows the river Sungari. Thence the journey continued down the Sungari to Kirin, and north-westward into Mongolia, eastward again, and southward through thriving colonies of strong, self-reliant, diligent Chinamen, to the Russian fort of Nova-Kievsk, south of Vladivostok. Thence they went back to Newchwang and Peking, experiencing all the severity of a Siberian winter, and observing amongst many objects of interest the curious phenomenon of a frozen mist, the particles of ice being so small that the whole air glittered in the sunlight. At Peking, Captain Younghusband was fortunate enough to get permission to return to India overland; and in the spring of 1887 he set out alone with a small party of Chinamen to find his way across the Gobi Desert to Kashgar (Fig. 1), and thence over the Karakoram Mountains into India by a route never previously taken by Europeans. The journey was full of incident, if not of adventure, as far as Hami, 2000 miles from Peking, which was reached in three months, at the end of July. The scenery of the Gobi Desert is powerfully described, and the singular character of the gravel-covered valleys, the cliffs, and the sand-dunes very clearly explained. It is a region of æolian formations where erosion by the alternation of heat and cold and the furious blasts of the prevailing winds has its full course unchecked and unassisted by water or ice. Several instances are recorded of heavy showers of rain, not one drop of which reached the parched ground, so rapidly did evaporation proceed in the hot lower air. Thence the route lay along the edge of the Tian-Shan Mountains to Kashgar, where the glory of the vegetation and the comforts of the Oriental city-life were fully appreciated after the weary crossing of the desert. From Kashgar he proceeded to Yarkand, and thence, with Balti guides, plunged into the sea of mountains with the object of reaching India by a new route. Few enterprises in modern mountaineering have been more daring or more successful than Younghusband's rediscovery and crossing of the Mustagh Pass, inexperienced as he was in the ice-craft of alpine climbers, and solely dependent on native guides, who had themselves never passed that way before. To an experienced and well-equipped alpinist the danger would perhaps be inconsiderable, but the high specialist's point of view is not that from which to judge the work of a traveller, unused to mountains, arriving worn from the desert with no mountaineering outfit.

Fig. 1.—Kashgar.

The next journey recorded is one of remarkable interest, bearing as it does on the political condition of the Indian frontier. It was a reconnaissance of the passes across the great mountain barrier from the north, and a visit to the almost-unknown valley of Hunza in 1889. On this occasion Captain Younghusband was accompanied by a small detachment of Gurkhas, the native Indian troops, whose praises as mountaineers and good companions have been sounded by every European who has had occasion to do difficult work in their company. The description of the primitive little State is so attractive, that the reader feels relieved when he is assured that since its subjection to the Indian Government local autonomy has been maintained, and only the raids of the mountaineers on their lowland neighbours have been checked.

In 1890 commenced a longer and more important journey, which led Captain Younghusband back to Yarkand and Kashgar, where he spent a winter studying the curious cosmopolitan population of the capital of Chinese Turkestan, and doubtless collecting information which, not concerning the general public, is not

referred to in the volume. An interesting contrast is noted between the dreamy philosophical indifference of the Chinese to all questions of geography and natural science, their absolute and voluntary ignorance of other countries, and the quick intelligence of the Turki and Indian merchants who travel far, observe keenly, and hold surprisingly clear views on the difficult political questions which the convergence of the domains of the three dominating powers of Asia brings to a focus in Kashgar. At length Captain Younghusband was ordered back to India, making an exploring expedition through the Pamirs on the way, and it is almost amusing to notice how little he speaks of the sport of that famous region; indeed, the killing of *Ovis poli* seemed to interest him less than the observation of the wolves which weed the herds of the old rams when the weight of years and horns makes their removal a benefit to their species. On the Pamirs there were great political problems in course of development, and such information as the reader gleans of Captain Younghusband's intercourse with Russian officers, only whets his desire for the full history of all that went on. At one time the officers of both nations were drinking the health of their sovereigns, and imparting useful hints as to dealing with exacting natives; the next day the Englishman was informed by his Russian friend that he must quit the Pamirs instantly for Turkestan, and sign an undertaking not to cross into India by any known pass. This was done; but instead of returning to the northern plain, Captain Younghusband set to work to discover an unknown pass, and so fulfilled his mission without breaking his word.

The remaining journeys were of less value as exploration, being carried out in the course of military and political duty in Hunza and Chitral, duty which gave to Captain Younghusband a unique knowledge of the intrepid mountaineers whose misguided rulers precipitated the recent war with the Indian Government. For the details of that war we are referred to the special book in which the author narrates his experience as correspondent of the *Times*.

Captain Younghusband gives in his preface one of the most powerful reasons for the inclusion of natural science in ordinary education. He says: "It has been a ceaseless cause of regret to me that I had never undergone a scientific training before undertaking my journeys. During the last year or two I have done what I can by myself to supply this deficiency; but amongst the Himalaya Mountains, in the desert of Gobi, and amid the forests of Manchuria, how much would I not have given to be able to exchange that smattering of Greek and Latin, which I had drilled into me at school, for a little knowledge of the great forces of nature which I saw at work around me."

With one more quotation we must close this notice. Captain Younghusband has been considering the universality of the law of evolution, and proceeds to apply it to the human species with somewhat remarkable results.

"The traveller," he says, "frequently associates with men who are little more than beasts of burden, and on his return he meets with statesmen, men of science, and men of letters of the first rank in the most civilised countries of the world. He sees every step of the ladder of human progress. And, so far as I have been able to make use of my opportunities of observation, I have not been impressed with any great mental superiority of the most highly-developed races of Europe over lower races with whom I have been brought in contact. In mere brain-power and intellectual capacity there seems no great difference between the civilised European and, say, the rough hill tribesmen of the Himalayas; and, in regard to the Chinaman, I should even say that the advantage lay on his side."

It is to the moral superiority of the European races that Captain Younghusband attributes their power over all the races of the East. The illustrations are comparatively few but good and well-chosen, as the specimen on p. 131 shows, while the maps are sufficient as regards number and scale, and show the routes very clearly.

HUGH ROBERT MILL.

PROFESSOR DAUBRÉE.

ONE of the brightest lights in the geological department of French science has been extinguished by the death of Prof. Daubrée, who has passed away at the ripe old age of eight-two years. Born at Metz on June 25, 1814, he early devoted himself to minerals and rocks, and from the École Polytechnique passed in 1834 into the Corps des Mines. In these early years he paid visits to the mining districts of different parts of Europe, and communicated papers on his observations to the Geological Society of France, the *Annales des Mines*, and the *Comptes rendus* of the Academy of Sciences. He already began to display that breath of view and width of sympathy which distinguished his career, for, while studying minutely the mineral districts of Scandinavia, he devoted much time and thought to the erratic formations then beginning to attract attention, and published his views regarding them. Gradually his attention was more and more directed to the experimental side of his favourite science. He studied the artificial production of various minerals, and entered upon a course of profound investigation in which he became the great leader, and did more than any other observer to advance that department of the science.

With a deep admiration for Sir James Hall, the true founder of experimental research in geological inquiry, he threw himself with especial ardour into the investigation of the influence of water-vapour on minerals and rocks when exposed to high temperatures and under great pressure. The difficult problems of metamorphism had a peculiar fascination for him, and he devoted himself with admirable patience to the task of trying to solve some of them by actual experiment. Every geologist who has studied these questions will feel that by the death of Daubrée, the great pioneer who first lighted up for us some of the darkest pathways of the subject has passed away. The various researches collected in his "Études Synthétiques de Géologie Expérimentale" have taken their place among the classics of modern science.

Nor were his investigations confined to the earth. He took special interest in meteorites, and besides diligently gathering specimens, studied their composition and structure, and carried on a series of experiments in order to reproduce their characters artificially, and thus to throw light on the chemistry of extra-terrestrial space. His last important volumes discussed in ample detail the phenomena of underground water, and traced the various solutions and changes which water is now producing and has formerly effected within the crust of the earth.

M. Daubrée spent the greater part of his scientific life in Paris, where he occupied official posts in the École des Mines and Muséum d'Histoire Naturelle. He retired from office two or three years ago, but continued to interest himself actively in scientific research. He was an indefatigable worker, and, like most busy men, found time for more than his own professional duties. He was one of the most regular attendants of the Académie des Sciences, and one of the most influential members of that distinguished body, serving on many of its Committees, and taking an active part in all its concerns. At its meeting last week, the Academy, after some eulogistic words from the President, at once rose in token of its respect. Daubrée was likewise a member of the Council of the Legion of Honour until the whole body resigned some time ago.

The death of his wife last year was a blow to him, from which he never seemed quite to recover. Yet at the Centenary of the Institute of France, last October, he took his part in the various functions, save those that required evening attendance. He accompanied the excursionists to Chantilly, and was welcomed there by the Duc d'Aumale as an old colleague and personal friend. He began to be somewhat ailing before Easter, and though for a time he appeared to rally, and hopes were entertained that his life might still be prolonged, he died peacefully on May 29, at his house in the Boulevard St. Germain.

A courteous and polished gentleman of the old school, M. Daubrée was everywhere a favourite. There was a certain gentle timidity of manner which gave him a peculiar charm. To those privileged with his friendship he was a warm-hearted kindly benefactor who never spared himself trouble to do a kind act, and to give proofs of the depth of his affectionate nature. A. G.

NOTES.

AT the annual meeting of the Royal Society for the election of Fellows, held on Thursday last, in the Society's rooms in Burlington House, the following gentlemen were elected into the Society:—Lieut.-Colonel Sir George Sydenham Clarke, R.E., Dr. J. Norman Collie, Dr. Arthur Matthew Weld Downing, Dr. Francis Elgar, Prof. Andrew Gray, Dr. George Jennings Hinde, Prof. Henry Alexander Miers, Dr. Frederick Walker Mott, Dr. John Murray, Prof. Karl Pearson, Rev. Thomas Roscoe Rede Stebbing, Prof. Charles Stewart, Mr. William E. Wilson, Mr. Horace Bolingbroke Woodward, and Dr. William Palmer Wynne. The investigations made by each of the new Fellows are set forth in the certificates printed in our issue of May 7.

A DISTINGUISHED philosopher, a wonderful orator, and a mind that was always on the side of advancement in science, art and literature, has been lost to France by the death of M. Jules Simon. He was a great educational reformer, and his voice and pen were always ready to support those things which make for the peace and progress of the world. At the celebration of the Centenary of the Institute of France, last October, he delivered a remarkable discourse, which was printed in full in these columns. His concluding words reflect the broadness of his mind so well, that they may be appropriately repeated now. "Associés et correspondants de l'Institut de France, vous n'emporterez pas seulement d'ici le souvenir des chaleureuses sympathies qui vous ont accueillis. Nous emporterons tous, de cette réunion fraternelle, un redoublement d'amour pour la paix, pour les sciences qui la fécondent et pour les arts qui l'embellissent; et nous travaillerons, chacun dans notre coin préféré de l'atelier universel, à la prospérité de la maison, c'est-à-dire au bonheur de l'humanité." The French Chamber has shown its appreciation of Jules Simon's services in the interests of humanity by voting ten thousand francs for a public funeral, and this has been unanimously agreed to by the Senate.

DR. ROUX has been elected an associate of the Academy of Medicine, in the room of the late M. Pasteur.

SIR GEORGE STOKES and Dr. Carl L. Griesbach, Director of the Geological Survey of India, have been elected honorary members of the Austrian Academy of Sciences.

THE annual conversazione of the Institution of Electrical Engineers will be held in the Galleries of the Royal Institute of Painters in Water Colours, Piccadilly, on the evening of Thursday, June 25.

AN agricultural bacteriological laboratory will shortly be opened at St. Petersburg, under the Ministry of Agriculture and State's Domains. Its chief purpose will be the study of the micro-organisms which are harmful to agriculture, and the pursuit of scientific studies in bacteriology. The laboratory is endowed with a yearly grant of 10,000 roubles (£1000) from the Treasury of the State.

THE members of M. Andrée's balloon expedition to the North Pole left Gothenburg on Sunday, June 7, on board the steamer *Virgo*, bound for Spitzbergen.

OWING to some difficulty in connection with the preparations for his new expedition to Greenland, Lieutenant Peary will be unable to come to England as he intended. The meeting of the Royal Geographical Society on Tuesday, June 16, at which he was to read a paper, will, therefore, not be held.

THE steam yacht *Windward* left St. Katharine's Docks on Tuesday with a very large supply of provisions, a number of sledges, and two additional members for the Franz-Josef Land party of the Jackson-Harmsworth Expedition. It is hoped that she will communicate with the explorers at Cape Flora, Franz-Josef Land, on or about July 20. As soon as the *Windward* has discharged her cargo, she will leave Franz-Josef Land with news of the doings of the explorers, and she may be expected in England by the end of September. About this time next year, if all has gone well, the ship will leave London again to bring the explorers home.

WE regret to record the death of Sir George Johnson, F.R.S., at the age of seventy-eight. He obtained his medical education in King's College Medical School, with which institution his life's work is intimately associated; for at different times he there filled the posts of medical tutor, professor of materia medica and therapeutics, professor of the principles and practice of medicine, and professor of clinical medicine. He was the author of numerous works and papers on medical subjects, the best-remembered of which will probably be those on cholera, epidemic diarrhœa, and Bright's disease. A melancholy interest is attached to the fact that his last work, on "The Pathology of the Contracted Granular Kidney," was published the day before his death. He was elected a Fellow of the University of London in 1862, and was admitted into the Royal Society ten years later.

TOWARDS the end of a long and highly appreciative notice of the life and works of the late Sir J. Russell Reynolds, whose death we briefly recorded last week, the *British Medical Journal* thus refers to the scholarly address which he delivered as president of the successful meeting of the British Medical Association held in 1895:—"His presidential address, as the last important public utterance of a distinguished man, has now a double interest. As we reperuse it we seem to read the departing words of a veteran to whom the sunset of life had already given mystical lore, and whose admonitions to those who shortly will reign in his room have assumed oracular force. At the end of a span of years greater than is usually allotted to men of our calling, he looks with calm survey over a period the most pregnant with scientific progress the world has ever yet known. In a series of terse, closely reasoned passages he points out the vast changes that have occurred in the entire theory and method of physic since he first set foot in a hospital ward, rejoicing in the advances made, warning his successors against the errors and defects that those very advances may beget. Science is great, wisdom is greater; the ampler the armament

of knowledge, the more need to strengthen and train the mind by which it must be carried, the judgment by which it must be exercised; such is the constant moral of Sir Russell Reynolds's final utterance to the medical world. Was it in a spirit of prophecy that he warned the subject-ridden student of to-day of the danger of becoming entangled in the net of an ill-considered and misunderstood technical phraseology, and of juggling with words when he ought to be dealing with concrete things? It was at least the warning of a man, rarer among us as the generations proceed, who had seen both sides of the intellectual shield; who was at once a scholar and a scientific physician."

THE Royal Medals and other awards made by the Royal Geographical Society for the encouragment of geographical science and discovery have, reports the *Geographical Magazine*, been assigned as follows:—The founder's medal, to Sir William Macgregor, for his long-continued services to geography in British New Guinea, in exploring and mapping both the interior and the coast-line, and in giving information on the natives; the patron's medal, to Mr. St. George R. Littledale, for his three important journeys in the Pamirs and Central Asia; the Murchison grant, to Yusuf Sharif Khan Bahadur, Native Indian Surveyor, for his work in Persian Baluchistan and elsewhere; the Gill memorial, to Mr. A. P. Low (of the Canadian Survey), for his five explorations in Labrador; the Back grant, to Mr. J. Burr Tyrrell (of the Canadian Survey), for his two expeditions in the Barren Ground of North-East Canada; and the Cuthbert Peek grant, to Mr. Alfred Sharpe, for his journeys during several years in Central Africa. The following geographers have been elected honorary corresponding members of the Society: M. P. de Semenoff, Vice-President of the Russian Geographical Society; Prof. Dr. Karl von den Steinen, President of the Berlin Geographical Society; Prof. Dr. G. Neumayer, Director of the Naval Observatory, Hamburg; Prof. A. de Lapparent, late President of Council of the Paris Geographical Society; Dr. Albrecht Penck, Professor of Geography in Vienna University; Prof. Dr. Otto Petterson, of Stockholm, the distinguished oceanographer; Prof. Dr. Kan, President of the Dutch Geographical Society; Sr. D. Ernesto do Canto, of São Miguel, Azores, who has edited a series of the Archives of the Azores; Prof. H. Pittier, Director of the National Physico-Geographical Institute of Costa Rica.

THE preliminary announcement of the Local Committee of the American Association for the Advancement of Science for the forty-fifth meeting, being the fourth Buffalo meeting, has just been issued. The meeting of the Association itself will be held August 24-28, and affiliated societies will begin their meetings on August 20, and will continue till September 1. On Monday morning, August 24, the retiring President, Prof. Edward W. Morley, will introduce the President-elect, Prof. Edward D. Cope. On Monday afternoon the several Vice-Presidents will deliver their annual addresses as follows:—Carl Leo Mees, before the section of physics, on "Electrolysis and some outstanding Problems in Molecular Dynamics"; Alice C. Fletcher, before the section of anthropology, on "Emblematic Use of the Tree in the Dakotan Group"; Ben. K. Emerson, before the geological section, on "Geological Myths"; Wm. E. Story, before the section of mathematics and astronomy, on "Intuitive Methods in Mathematics"; William R. Lazenby, before the section of social and economic science, on "Horticulture and Health"; Theodore N. Gill, before the section of zoology, on "Animals as Chronometers for Geology"; Wm. A. Noyes, before the section of chemistry, on "The Achievements of Physical Chemistry"; Nathaniel L. Britton, before the botanical section, on "Botanical Gardens"; Frank O. Marvin, before the section of mechanical science and engineering, on "The Artistic Element in Engineering." Prof. F. W. Putman is Permanent Secretary of the Association, and Eben P. Dorr, of Buffalo, is the Local Secretary for this meeting.

THE Geological Society of America will have a series of excursions before the meeting of the American Association, and will hold a business meeting on Saturday evening, August 22, at which papers will be presented by title, which are to be read and discussed in the geological section in the following week. This is a departure from the custom of previous years, when papers read before this Society detracted from the material presented to the geological section. Prof. Joseph Le Conte is President. Other affiliated societies, which meet two or three days before the General Association, are the American Chemical Society (Dr. Charles B. Dudley, President), Society for the Promotion of Agricultural Science (Prof. Wm. R Lazenby, President), Association of Economic Entomologists (Prof. C. H. Fernald, President), Botanical Society of America (Prof. Charles E. Bessey, President), Society for the Promotion of Engineering Education (Prof. Mansfield Merriman, President). A meeting of the American Mathematical Society will be held after the close of the Association meeting.

FROM a circular recently distributed we learn that Mr. W. Garstang, Fellow of Lincoln College, Oxford, will again conduct a vacation course of study in marine biology at the Plymouth laboratory during the ensuing summer, from July 23 to August 22, inclusive. Students who may desire to join the class should apply to Mr. Garstang before the end of the current month.

IN a contribution to the current number of the *Biologisches Centralblatt*, Dr. Imhof records some observations upon the effects of introducing eels into certain Alpine lakes which seem to him to discredit the generally received opinion that the fresh-water eel spawns only in the sea. The reproduction of the eel is a mystery which has hitherto baffled all attempts at solution; and naturalists may perhaps find some clue to the successful elucidation of the problem in Dr. Imhof's communication. It appears that eels were first introduced into three small Alpine lakes in canton Graubünden in the year 1882. In two of the ponds the fish apparently died; but in the Caumasee they flourished. Extensive additions were made to the stock in the lake in 1887. The eels still thrive well there and attain a length of 1·3 metres. No additions have been made to the stock since 1887, so that all the original eels must be at least eight or nine years old at the present time. Nevertheless, it was discovered last year that young eels were present in the lake: and the knowledge that both sexes are represented there, combined with this discovery, has led Dr. Imhof to the conclusion that the eels introduced into the Caumasee have multiplied in the lake itself. It should be mentioned that the Caumasee is 1000 metres above sea-level, has no apparent outlet, and is fed almost exclusively by subterranean springs. It seems improbable that the presence of the young eels can be due to natural immigration.

AT the recent annual meeting of the Selborne Society, Sir William Flower delivered an interesting address, which is printed in the June number of *Nature Notes*. In the course of his remarks he traced the rise and fall of local museums, and pointed a moral which cannot be too widely known. He said:—"A museum is started or established in some country town, a building is appropriated, various things are brought together, and the people who have done this think they have done a great thing towards cultivating a love for natural history. But in twenty or thirty years when you go again to that place, you will see the building and most of the specimens, but in such a condition that you might well think that the inscription 'Rubbish may be shot here' should be over the doorway. There are a few exceptions here and there, of course, but the

principal reason is that when people start a museum they forget one thing. If you were starting a school the first thing you would think of would be the schoolmaster. A church is of no use without a minister; a garden is of no good without a gardener. None of these things are expected to take care of themselves, yet that is what *is* expected of nearly all the museums in the country. They are set up and the exhibits are arranged, but the last thing anybody seems to think anything about is the curator. A curator is the heart and soul of a museum, and yet we have museums going to decay because nobody thought of the expense that is needful to keep a curator and his staff going. If the thousands, aye, tens of thousands, which have been spent on so-called technical education had only been spent in founding really good local museums—places where any one wishing to know about any bird, or stone, or plant, might go and see for themselves—for I maintain that a museum in its proper sense should be a place of instruction, not merely showing things stuffed and dried like miserable mummies, but giving instruction as to its nature and habit, and any other we might wish to know—what an immense store of useful information would have been gained."

PITHECANTHROPUS is still to the fore. Early this year the Royal Dublin Society published the paper Dr. Dubois read before that Society (*cf.* NATURE, No. 1362, vol. liii., 1895, p. 115), and now he has published a further communication in the *Anatom. Anzeiger* (vol. xii. p. 1), with several illustrations, in which he reiterates his conclusions. A table is given of nineteen anatomists who are classed according to whether they believe Pithecanthropus to be a simian, human, or transitional form; but we imagine that some may object to be tabulated in this form. It is a pity that the ideal reconstruction of the cranium on p. 15, should require to be corrected in two points. Dr. R. Martin has also published a small pamphlet on "further remarks on the Pithecanthropus question," in which he quotes the opinion of a large number of writers on the subject, and particularly lays himself out to attack Virchow; he believes that it is "a low variety of the species *homo*." M. L. Manouvrier concludes in the current number of the *Bull. Soc. d'Anthrop. Paris* (vi. 4e sér. fasc. 6) his erudite "Deuxième étude sur le *Pithecanthropus erectus* comme précurseur présumé de l'homme." This is the most searching scrutiny to which the remains have been subjected, and it forms the most important contribution to the general discussion. It will be remembered that the Javan femur is very human in its characters, the only non-typical differences (putting aside the pathological bony outgrowth) being in the popliteal region. M. Manouvrier has thoroughly discussed this point after having examined several hundred femora, and he finds that the femur of Pithecanthropus fits in a series with normal human femora, and it is not more simian than human; the peculiar variation of the Javan femur is associated with a weak musculature, and the latter may possibly be partly due to the pathological condition already noted; when another femur is discovered, it may be yet more human than this one. In his discussion on the skull, M. Manouvrier gives three alternative ideal restorations and several other comparative diagrams, and he comes to the conclusion that "the Trinil race has arisen from a race of species of very short stature." This is very important from a theoretical point of view; and, with the evidence now to hand, there seem to be grounds for believing that in the evolution of man the femur assumed its human characters in advance of the skull. M. Manouvrier denies that this is a case of microcephaly, and believes that the "missing link" has been found.

REPRODUCTIONS of the decorative artistic efforts of primitive folk are always of great value provided they are perfectly accurately copied. Mr. R. L. Jack, the Government Geologist of Queensland, has recently published a plate or reproductions of aboriginal cave-drawings from the Palmer Gold Field (*Proc. Roy. Soc. Queensland*, xi.), and though we welcome all signs of interest taken in native matters, we cannot but feel some suspicion in the present instance, as there are discrepancies between the figures and the text in certain details. Reproductions of aboriginal drawings lose almost the whole of their value unless the strictest accuracy is preserved. We hope that our colonial scientific societies will publish as many exact transcriptions of native art as they can obtain from travellers, before it is too late.

PROF. R. SEMON, of Jena, whose brilliant investigations on the development of Ceratodus and the Monotremes has already been referred to in these pages, has also turned his attention to the Anthropology of Australia. We cull from our contemporary *Die Natur* (1896, No. 20) the conclusions to which Dr. Semon has arrived respecting the vexed question of the origin of this people. As to culture grade the Australians are ranked above the Veddas, and slightly below the African Pigmies and the Bushmen; the Fuegans are of about the same grade, but the natives of Brazil and the Eskimo are higher. The Australians and Dravidians of India belong to one of the main stems of humanity. The Veddas of Ceylon, judging from the investigations of the Sarasins, belong to a small Pre-Dravidian branch; these arose at a low-culture grade, and have not made any progress since. Other early branches of the primitive Dravido-Australian stem seem to be the curious Ainus of Japan, and the Khmers and Chams of Cambodja. The White Race ("Caucasian") probably came from the Dravidian branch, and thus we Europeans are related to the low savages of Australia; very distantly, it is true, but these are nearer to us than are the Negroes, Malays, or Mongols. It may be noted that these conclusions of Prof. Semon's agree pretty closely with opinions expressed by several English anthropologists.

DR. WESLEY MILLS, Professor of Physiology in McGill University, Montreal, has recently published in the *Transactions* of the Royal Society of Canada (second series, section iv. vol. i. pp. 191-252) a series of papers on the psychic development of young animals. A year earlier, Dr. Mills published the first paper of the series dealing with the psychic development of the dog (St. Bernard and Bridlington terrier). This is now supplemented by observations on the cat, mongrel dog, rabbit, and guinea-pig, and, among birds, the pigeon and the chick. The records are in the form of diaries, from which comparisons and conclusions are then drawn. There is so little systematic record of observations on the instincts and habits of young mammals, that Dr. Wesley Mills' papers are especially welcome. Dr. Mills has also contributed to a discussion on instinct in the correspondence columns of *Science* during the last few weeks, in which Prof. Mark Baldwin also took part. Prof. Baldwin's letters (March 20 and April 10) and Dr. Mills' criticism (May 22) should be read by those interested in the interpretation of the phenomena of instinct in the light of modern theories of heredity.

DURING the last six or seven years, the observation of the pulsations from distant earthquakes has been facilitated by the invention of delicate instruments, such as the horizontal and bifilar pendulums and the long vertical pendulums used in Italy. The investigation of these interesting phenomena suffers, however, from two or three serious disadvantages, which can hardly be removed except by some form of combined action. The instruments employed are of several different types, and they are very unequally scattered over the earth's surface. Many pulsations, again, are recorded which, though of the usual seismic character, cannot be traced to any known earthquake, there

being many countries where no regular organisation exists for the study of these disturbances. We are therefore glad to draw attention to a circular issued by Prof. Gerland, of Strassburg, and signed by nearly all the leading seismologists. Starting from Japan, which possesses the most complete organisation for the study of earthquakes, they suggest a number of stations at which it is desirable that observations should be made. These stations are distributed as uniformly as possible over the earth's surface, and the following places are indicated as especially suitable:—Shanghai, Hongkong, Calcutta, Sydney, Rome, Tacubaya (Mexico), Port Natal, Cape of Good Hope, Santiago (Chili), and Rio de Janeiro. The horizontal pendulum of von Rebeur-Paschwitz is, in the first place, recommended for adoption. As a necessary supplement, it is proposed to form a centre for the collection and publication of reports on the earthquakes of the whole world. These are to be issued as supplements to Gerland's "Beiträge zur Geophysik." They will contain accounts of all earthquakes strong enough to damage well-built houses, and will give in each case the most exact details that can be obtained with reference to the position of the epicentre and the time-records at places adjoining it. Lists are also to be published of all earthquake pulsations registered by the horizontal and other pendulums. The scheme, for which we are chiefly indebted to the late Dr. E. von Rebeur-Paschwitz, can hardly fail to add greatly to our knowledge of earthquakes and their nature, even if it should have to be carried out on a scale less extensive than that now planned.

An interesting series of experiments on the transparency of liquids is described by M. W. Spring in the *Bulletin* of the Royal Academy of Belgium. The first of M. Spring's papers deals with the colours of the alcohols as compared with water. None of the alcohols observed were colourless when the thickness of fluid was 26 metres; methyl alcohol appeared greenish blue, ethyl alcohol the same, but of a less warm colour, and amyl alcohol greenish yellow. The pure blue colour observed in water becomes thus modified by the admixture of more and more yellow as we pass from one term of the homologous series of compounds to the next. The absorbing powers of the various liquids for ordinary light were also observed, and it was found that these formed a descending series, the simplest substance, water, offering the greatest resistance to the passage of light seen by the eye. In a second contribution, the same writer discusses the temperature at which the connection currents begin to produce opacity in a column of water of given length. Where the length is 26 metres the smallest difference of temperature that will suffice is about 0°·57, and is comparable with that which doubtless exists in lakes and seas. The author concludes that we have here an explanation of the varied colours so often seen on water. These result from the differences of temperature caused by sunshine, on the one hand, and by the cooling action of wind blowing on the surface, on the other.

In Nature of June 4, reference was made to a report from Missouri bearing on the question, "Do Röntgen rays exercise any influence on bacteria?" This question forms the title of a paper by Prof. G. Sormani (*Rendiconti del Reale Istituto Lombardo*), in which are described experiments made on sixteen different species of bacteria, both in cultures and when inoculated into living animals. As a result of these experiments, the author has to admit that Röntgen rays do not exercise any sensible action on the cultural and pathogenic properties of the bacteria on which he has experimented.

M. Gaspar Schmitz (*Bulletin de l'Académie Royale de Bélgique*) describes, with diagrams, a fine group of thirty-two upright tree trunks which were discovered in November last on the top of the coal-bearing strata in the Liège basin. There are two theories to account for the existence of these trunks viz. growth on the spot, or transportation from a distance; and from the evidence derived from careful examination of the surroundings, M. Schmitz appears, however, to incline to the latter theory.

The Deutsche Seewarte has issued the tenth yearly series of Daily Synoptic Weather Charts for the North Atlantic Ocean, prepared in conjunction with the Danish Meteorological Institute. The charts are drawn for each morning from December 1, 1890, to November 30, 1891, and embrace a large portion of the adjoining continents of Europe and America. The explanatory text, issued in separate quarterly parts, shows (1) the paths of all barometric minima, or areas of low pressure, with indications of the intensity of the depressions; (2) the positions and the changes of locality of the barometric maxima, or areas of high pressure; (3) the mean position of the isobar of 765 mm. (30·1 inches) for certain definite periods. We have before expressed our opinion that the value of this and similar laborious undertakings for the purpose of investigating the laws which underlie our weather changes, most of which reach us from the Atlantic, can hardly be over-estimated.

The Hydrographic Office of the United States continues the publication and wide distribution of its monthly Pilot Charts for the North Pacific Ocean. These charts contain much information of especial value to seamen, and show the mean average conditions of atmospheric pressure, winds and storms, the positions of areas of high and low barometer, and the principal sailing routes over that ocean. The chart for May last contains the track and log of the American schooner *Aida*, which recently made the passage from Shanghai to Port Townsend, Washington State, in the remarkably short period of twenty-seven days. This passage is an excellent example of what may be accomplished by a captain who takes advantage of existing meteorological conditions and of the information afforded by the Pilot Charts. In the case in point the conditions were certainly favourable, but not exceptionally so.

Limits of space prevent us from reviewing, or even enumerating, the whole of the articles in several bulky volumes recently received; all we can do is to direct attention to their publication. The annual of the Bergen Museum—"Bergen's Museums Aarbog"—for 1894–95 contains numerous papers on physical and natural science, archæology and history, printed in Norsk, German, and French. Among the subjects of the papers are:—Results of cross-fertilisation of fishes, the systematic ennumeration of the marine polyzoa of Norway, the geology of the glacier of Hardanger, the geology and archæology of the plateau of Hardanger, ichthyological notices, foraminifera collected near Bergen during 1894, the decomposition of albuminoids in the human organism, echinoderm fauna in the western fiords, mosses of the Sandefiord region, a certain differential equation, and algæ of the western coast of Norway. The volume also contains reports of the collections and work of the Museum during 1894 and 1895. The "Sitz. der königl. bohmischen Gesellschaft der Wissenschaften at Prague," for 1895, comes to us in two volumes, each filled with papers of scientific value, and many well illustrated. There are altogether fifty-three papers and forty-five plates. Unfortunately for scientific readers having only a limited acquaintance with foreign languages, many of the papers are printed in Chech. Among the subjects dealt with are the Arachnida of Bohemia and Moravia, by Prof. A. Nosek; the chalk formation in the neighbourhood of Ripu, by Prof. V. Zahálka; the palæontology of the older palæozoic formations in Central Bohemia, by Dr. F. Katzer; new descriptions of Tubellaria, by Prof. F. Vejdovski; anemometer observations at Prague, by Dr. J. Frejlach; a contribution to the electromagnetic theory of light, by Prof. F. Koláček; monograph of the fossil flora of Rossitz, Moravia, by

Dr. F. Katzer; some curious geological effects produced by wind-borne sand, by Prof. J. N. Woldřich; the anatomy and development of the brain of vertebrates, by F. K. Studnička; the development of Stylomatophora, by J. F. Babor; determination of the altitude of the celestial pole by means of photography, by Prof. V. Láska; on *Baculus elongatus* (Lubbock) and *Lernæa branchialis*, a contribution to the anatomy of Lernæadæ, by A. Mrázek; studies of isopoda, by B. Němec; on electrolytic superoxide of silver, by Dr. O. Šulc; studies of the Coccidæ, by K. Šulc (this paper is summarised in English); the histology and histogenesis of the spinal cord, by Dr. F. K. Studnička; and new vertebrates from the Permian formation of Bohemia, by Prof. A. Fritsch.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mrs. Bouveri; two Slow Lorises (*Nycticebus tardigradus*), a —— Toad (*Bufo asper*) from Penang, a Roseate Cockatoo (*Cacatua roseicapilla*) from Australia, a Lesser Sulphur-crested Cockatoo (*Cacatua sulphurea*) from Moluccas, two Spinose Land Emys (*Geomyda spinosa*), a Black-spotted Toad (*Bufo melanostictus*) from Singapore, presented by Mr. Stanley S. Flower; two Hairy Armadillos (*Dasypus villosus*) from Uruguay, presented by Messrs. FitzHerbert, Bros.; a Coati (*Nasua rufa*) from South America, presented by Mr. Ernest Brocklehurst; two Herring Gulls (*Larus argentatus*), two Black-headed Gulls (*Larus ridibundus*) British, presented by Baron Ferdinand de Rothschild; a Javan Porcupine (*Hystrix javanica*, white var.) from Java, a Leopard Tortoise (*Testudo pardalis*), a Natal Python (*Python sebæ*, var. *natalensis*) from South Africa, a Cunningham's Skink (*Egernia cunninghami*) from Australia, deposited; a Japanese Deer (*Cervus sika*, ♂), a Red Deer (*Cervus elaphus*, ♀), two Thars (*Capra jemlaica*, ♀ ♀), a Huanaco (*Lama huanacos*, ♂), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

OCCULTATION OF JUPITER.—On the evening of June 14 there will be an occultation of Jupiter and his satellites. The planet will disappear at 9h. 52m. G.M.T. at an angle of 113° from the north point towards the east, and reappear at 10h. 43m. at the position angle 293°. The moon will be about three and a half days old, but as it will set at 10h. 56m. the reappearance will occur under unfavourable conditions of observation. The sun will pass below the horizon of Greenwich at 8h. 16m. on the 14th.

COMET SWIFT.—The following elements for comet Swift, 1896, have been derived by F. Bidschof (*Ast. Nach.*, No. 3356).

T = 1896 April 17·68237 (Berlin M.T.)

$$\left.\begin{aligned} \omega &= 1^\circ\ 43'\ 55''\cdot3 \\ \Omega &= 178\ \ 15\ \ 28\cdot1 \\ i &= 55\ \ 33\ \ 42\cdot8 \end{aligned}\right\} 1896\cdot0$$

$$\log q = 9\cdot753076$$

The following is a short ephemeris, the unit of brightness being that on April 19:—

	R.A. h. m. s.	Decl. ° ′	Brightness.
June 11	22 17 17	+72 43	0·05
15	21 52 31	72 21	0·05
19	21 29 5	71 46	0·04
23	21 7 20	70 57	0·03
27	20 47 29	69 57	0·03
July 1	20 29 38	+68 45	0·03

The last published observation is that of Dr. Engelhardt on May 11 (*Ast. Nach.*, No. 3353), when the comet was reported "faint."

SPOTS AND MARKINGS ON JUPITER.—During the past seventeen years Prof. Hough, of the Dearborn Observatory, has made an almost unbroken series of observations of the markings of Jupiter, with the special aim of studying the phenomena by means of micrometrical measures of size and position, rather than by sketches. He considers that for the proper interpretation of the changes taking place, such measurements, extending over a long period of time, are absolutely necessary, while the study of latitude variations is likely to lead to results as important as those of rotation period (*Ast. Nach.*, No. 3354). Photographs have been regarded as capable of giving results as accurate as micrometric measures in the telescope, but long experience has led Prof. Hough to doubt this conclusion. Notwithstanding its varying visibility, the size and shape of the great red spot have changed very little since 1879, though during recent years it was possibly 1″ shorter than when it was most conspicuous. The very slight change in the latitude of the spot during the last seventeen years seems to indicate that this object is the most stable of any of the markings. The average length of the spot, reduced to mean distance, has been 11″·61 or 37°·2. Measures of the equatorial belt and of several spots are also given, and it is worth noting that there are many advantages in Prof. Hough's method of expressing latitudes in direct measures of angular distance. A very suggestive observation was made on February 13, 1895. The third satellite was then observed in transit, at first as a black spot, but afterwards as a white disc; "after emersion, when the distance from the limb of the planet was 0″·4, the outline was sharply defined, and there was an absence of glow around the disc as though the satellite was immersed in a medium which absorbed some of its light."

COMET PERRINE-LAMP (1896 I.), which attracted considerable attention in the early part of the year, has probably now passed out of reach of even the largest telescopes. M. Schulhof has computed hyperbolic elements for this comet; but while the hyperbolic character of the orbit is still uncertain, it is established that the comet is not one of short period.

THE RELATIVE LENGTHS OF POST-GLACIAL TIME IN THE TWO HEMISPHERES.

SOME interesting observations on underground temperature have recently been made at Cremorne, near Port Jackson, in New South Wales.[1] The bore is 2939 feet deep, the mean temperature at the surface is 63° F., and the temperature at the depth of 2733 feet was found to be 97° F. The observations having been made with great care, the resulting gradient of 1° F. per 80 feet would appear to be "a good approximation to the truth." The rocks of the district down to a depth of about 3000 feet consist of sandstones, shales and conglomerates, and therefore, so far as conductivity is concerned, seem to be not unlike the rocks penetrated by the shafts of coal-mines in the north of England, or those in which Forbes' rock-thermometers were sunk in the neighbourhood of Edinburgh.

The estimates of the relative lengths of post-Glacial time in the two hemispheres, given on p. 138, are based on the following assumptions, the first three of which, it is needless to say, are only rough approximations to the truth. It is supposed (1) that in each hemisphere the gradient beneath the ice-sheet at the close of the Glacial period was the same[2]; (2) that the gradient at the surface may now be taken as equal to the average gradient over the whole boring; (3) that when the ice-sheet disappeared, the mean temperature of the district rose *suddenly* to its present value; and (4) that, previously to its disappearance, the temperature of the ground at the base of the ice-sheet was that of the freezing-point of water due to the pressure of the ice above, say 30°·5 F.[3]

The change in the gradient near the surface after a lapse of t years, due to a rise of b degrees in mean surface temperature, is $b/\sqrt{(\pi\kappa t)}$, where κ is the conductivity of rock expressed in terms of its own capacity for heat.[4] Now, the mean temperature over England averages 49°·5 F., so that b is here 19°, and the temperature gradient in the north of England is 1° per 49 feet.[5] Hence,

$$\frac{19}{\sqrt{t}} = \sqrt{(\pi\kappa)}\left(\frac{1}{x} - \frac{1}{49}\right),$$

[1] Report of B. A. Underground Temperature Committee, 1895.

[2] This implies that the Glacial period was of the same—or, if not, of very great—length in each hemisphere.

[3] See a paper "On the Effect of the Glacial Period in changing the Underground Temperature Gradient" (*Geol. Mag.*, vol. ii., 1895, pp. 356-360).

[4] Rev. O. Fisher, *Phil. Mag.*, vol. xxxiv., 1892, p. 339.

[5] Sir J. Prestwich, "Controverted Questions of Geology," p. 203.

where 1° per x feet is the unknown gradient at the end of the Glacial period. At Port Jackson, b is 32°·5, and the gradient 1° per 80 feet. If t' be the corresponding value of t, we have

$$\frac{32 \cdot 5}{\sqrt{t'}} = \sqrt{(\pi\kappa)}\left(\frac{1}{x} - \frac{1}{80}\right),$$

and therefore

$$\frac{32 \cdot 5}{\sqrt{t'}} - \frac{19}{\sqrt{t}} = \sqrt{(\pi\kappa)}\left(\frac{1}{49} - \frac{1}{80}\right).$$

Lord Kelvin, making use of Forbes' observations, finds κ to be 400, so that the last equation reduces to

$$\frac{65}{\sqrt{t'}} - \frac{38}{\sqrt{t}} = 0 \cdot 56.$$

This is satisfied if t and t' are both 2325 years, but so small a length of post-Glacial time is of course inadmissible. But, if t be increased beyond this value by any amount, it may be shown that t' is increased by a smaller amount; that is to say, the length of post-Glacial time must be greater in the north of England than at Port Jackson.

The following table contains some numerical estimates of the relative lengths of post-Glacial time in these districts, calculated from the last equation:—

North of England. Years.	Port Jackson. Years.
10,000	4,800
20,000	6,100
30,000	6,900
40,000	7,500
50,000	7,900
100,000	9,100

Too much stress should not of course be laid on these figures. The second and third, especially, of the assumptions on which they are based, must certainly be far from true. But, at any rate, it seems clear that the ice must have left the neighbourhood of Port Jackson much more recently than it left the north of England.

Whether this conclusion points to an alternation of the Glacial periods in the two hemispheres, and so furnishes an argument in favour of Croll's theory, is perhaps doubtful. But it shows, I think, how important it is, from a geological point of view, that further temperature observations should be made in the coal-mines and other borings of Australia, New Zealand, and South Africa.

C. DAVISON.

PLANT-BREEDING.

WE are most of us now-a-days so much accustomed to see our gardens or our houses bedecked with flowers, and our tables supplied with vegetables and fruit, that we take these things for granted, and do not trouble to inquire whence they come or how they are produced. But if we look back even a few years, we shall see how much larger a share plants have now in our lives than they had then. We shall see, moreover, that while there has been enormous numerical increase, there has also been in many cases continued progression in form and other attributes. We are not concerned here with the introductions from foreign countries, important though they are; our business for the moment lies with the changes resulting from the natural processes of variation as controlled by the art of the gardener. The garden roses of to-day, for instance, are not the roses of a dozen years ago, and as to the sorts that were grown by our fathers and grandfathers, they have, with some few exceptions, utterly gone. It is the same with peas and potatoes, and with most other plants that are grown on a large scale. True, there are some exceptions; there are some "good old sorts," which seem to show by their persistence that they are the fittest to survive under existing conditions. The black Hambro' grape is an illustration, the old double white Camellia is another; but these plants are not reproduced by seed, and therefore do not invalidate the rule, that each succeeding generation of plants differs in some degree from its predecessor. At first the differences are slight, and it may be imperceptible to all but the trained expert; but they become more accentuated as time goes on, till at length they eventuate in forms so different from that from which they sprang, that they would undoubtedly be considered of specific, if not of generic, rank, were not their history known. The Jackman Clematis and its near allies may be cited as cases in point, and still more remarkable are the tuberous Begonias, which, like the Clematis just mentioned, have been created, so to speak, within the last quarter of a century, and which are so different from anything previously known amongst Begonias, that they have actually been raised to the dignity of a genus by M. Fournier, a French botanist. Pansies and Auriculas—garden productions both—are now, morphologically speaking, as good species as are most of the groups of individuals to which this rank is assigned by naturalists. Of their seedlings a large proportion comes true—that is, the parental characteristics are so far reproduced that there is no greater amount of variation among the offspring of many of these artificially-made species than there is in the progeny of natural species. If, as is the case in some Auriculas and the gold-laced Polyanthus, we find little change has occurred during the last few years, may not this relative invariability be the result of the gradual assumption of a degree of stability which we usually associate with the idea of a species? Again, it often happens that these high-bred, close-fertilised plants become sterile, so that their continuance can only be ensured by cuttings, or some means of vegetative propagation. Is not this analogous to the retrogression and ultimate extinction which occur in natural species? It is not necessary here to cite more illustrations; our concern lies rather with the way in which these changes are brought about. This leads us to what is called the improvement of plants, or plant-breeding. There seems to be a growing tendency to make use of the latter term; but if it is to be adopted, it must be taken in a broad sense, and not limited to the results of sexual propagation.

The two methods, made use of by gardeners and plant-raisers for the improvement of plants, are selection and cross-breeding—the latter, as far as results are concerned, only a modification of selection. The natural capacity for variation of the plant furnishes the basis on which the breeder has to work, and this capacity varies greatly in degree in different plants, so that some are much more amenable and pliant than others. The trial-grounds of our great seedsmen furnish object-lessons of this kind on a vast scale. Very large areas are devoted to the cultivation of particular sorts of cabbage, of turnips, of peas, of wheat, or whatever it may be. The object is two-fold—primarily to secure a "pure stock," and secondarily to pick out and to perpetuate any apparently desirable variation that may make itself manifest.

The two processes are antagonistic—on the one hand, every care is taken to "preserve the breed," and to neutralise variation as far as possible, so that the seed may "come true"; on the other hand, when the variation does occur, the observation of the grower marks the change, and he either rejects the plant manifesting it as a "rogue," if the change is undesirable, or takes care of it for further trial, if the variation holds out promise of novelty or improvement. It is remarkable to note how keen the growers are to observe the slightest change in the appearance of the plants, and to eliminate those which do not come up to the required standard, or which are not "true." Where the flowers lend themselves freely to cross-fertilisation by means of insects, as is the case with the species and varieties of Brassica, it is essential, in order to maintain the purity of the offspring, to grow the several varieties at a very wide distance apart. In passing along the rows or "quarters," the plant-breeder not only eliminates the "rogues," and retains what he thinks may be desirable variations, as we have said, but he specially marks those plants which most conspicuously show the characteristic features of the particular variety he desires to increase, and he takes care to obtain seed from the plants so marked. The variety thus becomes "fixed," but it is obvious that that word is only used relatively; really, there is a constant change, which may be either in a retrograde direction, or which may be looked on as an amelioration. Thus, in the seedsmen's advertisements we see announcements of this character: "So-and-so's *Improved* Superlative Cucumber" or whatever it may be. This "improvement," when it exists, is the result of the careful scrutiny, elimination, and selection exercised by the raiser. These are repeated season after season, till a degree of fixity is attained and a good "strain" is produced.

Fierce competition and trade rivalry forbid the growers to relax their efforts, and thus it happens that the pea or the potato of to-day is not the same, even though it may be called by the same name as its predecessors. To the untrained eye, the primordial differences noted are often very slight; even the botanist, unless his attention be specially directed to the matter

fails to see minute differences which are perceptible enough to the raiser or his workmen. Nor must it be thought that these variations, difficult as they are to recognise in the beginning, are unimportant. On the contrary, they are interesting, physiologically, as the potential origin of new species, and very often they are commercially valuable also. These apparently trifling morphological differences are often associated with physiological variations which render some varieties, say of wheat, much better enabled to resist mildew and disease generally than others. Some, again, prove to be better adapted for certain soils or for some climates than others; some are less liable to injury from predatory birds than others, and so on. These co-relations, then, are matters of the greatest importance to the biologist intent upon the study of progressive modification, and to the merchant and the cultivator for practical reasons.

So far we have been alluding to variations in the plant as grown from seed, but similar changes are observable in the ordinary buds, and gardeners are not slow to take advantage of these variations. The buds taken from the base of a plant not unfrequently differ from those which are developed higher up, and these differences are perpetuated by propagation by means of cuttings or grafts. An interesting illustration of the variability in flower-buds is furnished by the gigantic Chrysanthemums which attract so much attention in late autumn. Without entering into technical details, it may be briefly stated that the cultivator selects certain buds, or one bud occupying a special position, and pinches off and rejects most or all the others. The result is not only a flower-head of large size, such as we might expect under the circumstances, but also, in very many cases, one which presents different characteristics to those which are manifested by the other buds when allowed to develop themselves. "As like as two peas in a pod" is, therefore, a motto which has not the significance it had before we had observed that the peas are mostly different, sometimes very much so, and the same thing happens, as has been shown, in the ordinary leaf- and flower-buds; doubtless each cell has its peculiarity, which only awaits a Röntgen ray or some other means to become visible.

Before we leave the subject of buds, some mention may be made of that form of bud-variation which the gardeners speak of as "sporting." Sports are bud-variations which occur suddenly, without assignable cause, and often simultaneously in different regions widely separate. Thus we get peaches and nectarines on the same bough, black and white grapes on the same shoot, or even in the same bunch, finely-cut leaves on a branch that normally produces broad or entire leaves, and so on. The gardener who is on the alert takes care to remove such buds, and to propagate them by cuttings or grafts. If raised from cuttings or layers, the duration of the sport is indefinite; if propagated by grafting, their duration is naturally conditioned by the life of the stock. The problems afforded by sports are of great interest, and are by no means fully solved. Many of them may arise from atavism, or a reversion to an ancestral condition; but of this there is no proof, neither can we appreciate the reason why such reversion should take place. Some may be the result of the dissociation of previously mixed characteristics. Of this we frequently see unmistakable evidence. Thus hybrid berberries frequently show on the same plant an un-mixing or separation of the characters belonging to the two parent-forms.

This brings us to the subject of cross-breeding as a means of obtaining new or improved varieties. Cross-breeding may occur in all degrees from the case where the pollen of one flower is transferred, by insect or other agency, to the stigma of another on the same branch, to that in which the pollen is transferred to the flower on a plant of a different species. Watch a bee travelling over the great disc of a sun-flower, and it will become obvious that (always provided the stigmas be in a receptive condition) cross-fertilisation of neighbouring flowers must take place.

There are endless adaptations which ensure cross-fertilisation, and on the other hand there are very numerous structural arrangements which necessitate close fertilisation, or the fertilisation of a flower's ovules by pollen produced in the same blossom. In view of the copious literature on this matter, it is not necessary here to enter into further detail. It is enough to say that some of the most astonishing results of the gardener's art are due to this practice of repeated cross-fertilisation. When the cross is effected between plants of two different species the term "hybridisation" is made use of, but it is obvious that there is only a difference of degree between the fertilisation of different flowers on the same plant and that of flowers belonging to different species, or even genera.

The tuberous Begonias, before alluded to, are the results of the successive intercrossing or hybridisation of several species, and the result is the production, within little more than a quarter of a century, of a race or garden-group, not to be matched in nature, and so distinct as to have been thought worthy not merely of specific but of generic rank.

Many recognised genera, we might even say most, are not so sharply differentiated as are these Begonias from others of the same family. These extreme crosses apparently are not effected under natural conditions, and some botanists even hesitate to admit the occurrence of hybrids in nature except under very exceptional circumstances. The gardeners and cultivators, however, have long considered certain forms to be of hybrid origin, and one of the most interesting things in this connection of late years is the positive evidence which cultivators have been able to bring forward as to the existence and the parentage of natural hybrids. Certain orchids, now rather numerous, were, from the appearances they presented, assumed to be "natural hybrids" between certain species. That such assumptions were correct has now been proved by the production in our orchid houses of forms indistinguishable from those met with in a wild condition, as the direct consequence of the designed fertilisation of one flower by the pollen of another.

Fairchild, a nurseryman at Hoxton, and the founder of the Flower-sermon, was the first on record to raise a hybrid Pink. Indeed, this is the first artificial hybrid of any kind on record, and it dates from 1719. From that time to this gardeners have gone on selecting, cross-breeding, hybridising. At one time some good folk looked askance at such operations as an interference with the laws of Providence. So much was this the case, that one eminent firm of nurserymen in the early part of the century led their customers to believe that certain heaths (Ericas), which they had for sale, were imported direct from the Cape of Good Hope, instead of having been raised by cross-fertilisation in their own nurseries at Tooting!

Gardeners for the most part pursue their experiments with no scientific aim. The names of Philip Miller, Thomas Andrew Knight, and of Dean Herbert, amongst others, suffice to show that some gardeners appreciate the deep scientific value of these every-day procedures. From the labours of these men and their successors it is made obvious that the cultivator, by availing himself of natural tendencies and natural agencies, and by his power of eliminating conflicting or unpropitious elements, does actually bring about, in a relatively very short period, the same results that occur under natural conditions only after the lapse of a prolonged period. Do not these facts show the desirability for our own biologists to study carefully the results obtained by the gardener, and better still to enter, as their great leader Darwin did, the field themselves as experimenters.

There can be few departments in which greater promise of important results can be held out.

MAXWELL T. MASTERS.

THE ROYAL OBSERVATORY, GREENWICH.

ON Saturday last, the Astronomer Royal presented his annual report to the Board of Visitors of the Royal Observatory, Greenwich. Following the usual custom, a number of astronomers and other men of science were invited to inspect the buildings and instruments of the observatory. The subjoined extracts from the report give a general idea of progress made in some departments since the middle of May last year.

Work with Equatorials.

The new equatorial with photographic telescope of 26 inches, presented by Sir Henry Thompson, is now nearly finished and ready for inspection at Sir Howard Grubb's works. Sir Henry Thompson has completed his valuable gift by the addition of a Cassegrain reflecting telescope of 30 inches aperture, to be carried in place of the counterpoise at the other end of the declination axis.

The 28-inch refractor has been in constant use for micrometric observations during the year, and for spectroscopic observations till November last year.

The measures of the dimensions of Saturn and his rings,

begun last year, were continued on nine nights, and the results communicated to the Royal Astronomical Society in November. The diameters of Jupiter were measured on nineteen nights with the filar micrometer and, for comparison, with the double-image micrometer; the results were communicated to the Royal Astronomical Society in May. The weather during the opposition of Jupiter and Neptune made it impossible for any systematic search to be made for Jupiter's fifth satellite, and the position of Neptune's satellite was only observed on one night.

The Photographic Chart and Catalogue.

With the Astrographic Equatorial 502 plates, with a total of 1224 exposures, have been taken on 123 nights in the year ending May 10, 1895. Of these, 135 have been rejected for various reasons.

The following statement shows the progress made with the photographic mapping of the heavens between May 11, 1895, and May 10, 1896:—

	For the Chart (Exposure 40 m.).	For the Catalogue (Exposures 6 m., 3 m., and 20 s.).
Number of photographs taken	118	353
,, successful plates	89	247
,, fields photographed successfully	79	223
Total number of fields photographed successfully since the commencement of the work	490	732

The question of the utilisation of the photographs taken for the Astrographic Chart, and the formation of a catalogue of stars down to the eleventh magnitude by means of photography, has occupied much attention during the past year, and a satisfactory working scheme for the measurement of the photographic plates and determination of the positions of the stars on them has been brought into operation. It is estimated that if no unforeseen difficulties arise the measures and calculations for the Greenwich Astrographic Catalogue of Stars down to the eleventh magnitude, from Dec. 64° N. to the Pole, will be completed in about seven years, and that the positions of about 120,000 stars will be determined with a degree of accuracy at least twice as great as that of the Astronomische Gesellschaft Catalogues from meridian observations. When it is considered that the Greenwich Astrographic Catalogue will contain about ten times as many stars as the catalogues of the Astronomische Gesellschaft for the corresponding zones, and that the Astrographic Catalogue for the whole heavens will give the positions of from two to three million stars with an accuracy hitherto unattained, and at a relatively small expenditure of labour, the great advantage resulting from the application of photography to the mapping of the heavens will be sufficiently evident.

Spectroscopic and Heliographic Observations.

Since the date of the last report, 189 measures have been made of the displacement of the F line in the spectra of 17 stars, as well as 33 measures of the F line in the spectrum of the moon for comparison.

The spot activity of the sun has steadily declined from the date of the last report. The mean daily spotted area of the sun was decidedly smaller in 1895 than in 1894, but a greater number of small spots was observed.

Magnetic Observations.

The variations of magnetic declination, horizontal force and vertical force, and of earth currents have been registered photographically, and accompanying eye observations of absolute declination, horizontal force and dip, have been made as in former years.

The principal results for the magnetic elements for 1895 are as follows:—

Mean declination	16° 57′·4 West.
Mean horizontal force	3·9739 (in British units). 1·8323 (in Metric units).
Mean dip (3 months, January to March)	67° 15′ 3 (by 9-inch needles). 67° 14′·8 (by 6-inch needles). 67° 16′·6 (by 3-inch needles).
Mean dip (4 months, September to December)	67° 10′ 7 (by 9-inch needles). 67° 11′·8 (by 6-inch needles). 67° 12′·4 (by 3-inch needles).

Uncertainty attaches to the results for mean horizontal force, owing to the permanent effect of the iron in the new Altazimuth Pavilion.

From April to August 1895, during the progress of the building work on the new Altazimuth, the observations of magnetic dip were subject to great uncertainty on account of the masses of iron for the building being stored near the north end of the New Library in immediate proximity to the dip instrument. And after the completion of the building—that is to say, since September 1895—the results of magnetic dip are affected to the extent of about 3′ or 4′ by the permanent iron in the building and instrument. An independent determination at a place sufficiently removed from the Altazimuth building is urgently required. The question, however, has necessarily been deferred, pending the settlement of the site for the new Magnetic Pavilion, which is to be built in Greenwich Park.

The magnetic disturbances during the year 1895 have been comparatively trifling. There were no days of great magnetic disturbance, and sixteen days of lesser disturbance. Tracings of the photographic curves for these days, selected in concert with M. Mascart, will be published in the annual volume as usual. The calculation of diurnal inequalities from five typical quiet days in each month has been continued.

Meteorological Observations.

The mean temperature of the year 1895 was 49°·3, being 0°·1 below the average for the 50 years 1841–1890.

During the twelve months ending April 30, 1896, the highest daily temperature recorded was 87°·3 on September 24. On May 30 a temperature of 86°·2 was recorded. The temperature rose above 80° on 26 days in 1895 as compared with seven days in the preceding year. The monthly mean temperatures were all in excess of the average values with the exception of the month of October, which was in defect. The mean for September was in excess to the amount of 4°·7; that for November in excess by 4°·2, and that for March 1896 by 4°. The mean temperature for the twelve months May 1895 to April 1896 was 51°·1, being 1°·7 above the 50 years' average.

The characteristics of the fine and hot month of September require to be examined in detail. It has been mentioned that the highest temperature of the year (87°·3) occurred on September 24, a temperature greatly exceeding all temperatures previously recorded at this advanced period of the year during the 54 years 1841–1894. Only two instances of higher temperature, both in the earlier part of the month, have been experienced in September, viz. 92°·1 on September 7, 1868, and 87°·7 on September 1, 1886.

The winter of 1895-96 was very mild, and there were only 19 days on which the temperature of the air fell to or below the freezing-point. The lowest winter temperature was 24°·3 on February 25, 1896.

The mean daily horizontal movement of the air in the twelve months ending April 30, 1896, was 275 miles, which is 6 miles below the average for the preceding 28 years. The greatest recorded movement was 1002 miles on December 5, and the least 70 miles on October 20. The greatest recorded pressure of the wind was 27·5 lb. on the square foot on March 16, with an extreme hourly velocity of 49 miles.

The number of hours of bright sunshine recorded during the twelve months ending April 30, 1896, by the Campbell-Stokes instrument was 1176 out of the 4465 hours during which the sun was above the horizon, so that the mean proportion of sunshine for the year was 0·263, constant sunshine being represented by 1. In the corresponding period for 1894–95 the number of hours of sunshine was 928, and the mean proportion 0·208.

The rainfall for the year ending April 30, 1896, was 19·76 inches, being 4·78 below the 50 years' average. This is the smallest rainfall since the year 1884–85, when the fall was 19·61 inches. In 1864-65 the rainfall was 17·71 inches, and in 1858–59 it was 17·38 inches. The number of rainy days in the twelve months was 151.

Re-organisation of the Staff.

The scheme for the re-organisation of the staff, referred to in last two reports, has now been sanctioned. With a view to strengthening the supervising power and increasing the permanent subordinate staff, an additional chief assistant is appointed, and the five second-class assistants of the old staff are to be replaced by eight established computers, two of these to be of a higher grade, the number of temporary computers being correspondingly reduced. The future staff will be thus constituted:—

Upper staff, two chief assistants and five assistants; lower staff, two higher grade established computers and six established computers; temporary staff, non-established computers.

Mr. P. H. Cowell was appointed the additional chief assistant on April 20, and it is hoped that the appointments of the established computers will very shortly be made. Mr. Criswick has retired on pension after a useful and honourable service of forty-one years at the Observatory, and Mr. Hollis has been promoted to fill the vacancy thus occasioned in the staff of first class assistants.

THE ROYAL SOCIETY OF CANADA.

THE annual meeting of the Royal Society of Canada was held at Ottawa on May 18, and the three following days. In addition to the papers read before the literary sections of the Society, a large number of important papers were presented in the two Science Sections.

In Section III. (Mathematical, Physical and Chemical Sciences), Profs. Cox and Callendar presented the results of recent investigations carried on by them in the physical laboratories of McGill University, in which they have succeeded in demonstrating that Röntgen rays are not unaffected by magnetic attraction, as Röntgen states, but on the contrary are affected in a marked manner when tested experimentally under favourable conditions, the approach of the magnet causing a marked deviation of the kathode rays within the tube in one direction, and at the same time a corresponding deviation of the Röntgen rays without the tube in the opposite direction. These observations are of especial importance as bearing on the question of the relation of Röntgen rays to the kathode-rays, Rontgen having considered the former as differing from the latter in that they were not influenced by magnetism.

In the same Section, papers were also read by Messrs. Alex. R. Mellanby and John T. Farmer, Royal Commissioners' Scholars, on investigations carried out in the laboratories of McGill University; the former, "on an investigation as to the thermal and plant efficiencies of compound, triple and quadruple expansion engines," and the latter, "on the efficiency of $\frac{1}{2}$-inch jets from circular orifices, impinging upon surfaces of different forms."—Prof. Bovey communicated the results of a series of experiments on the strengths of the woods of the hemlock, red pine, and white pine.—Mr. Howard Barnes presented the results of a series of very accurate measurements of the temperature of the waters of the St. Lawrence, opposite Montreal, during the coldest part of last winter. It was shown that the greatest variation in temperature did not exceed $\frac{1}{100}$ of a degree Centigrade. The measurements were carried out with a view to ascertaining whether the formation of frazil ice was accompanied by any considerable changes in temperature, such as have been described by some observers. It was found that as the river does not vary throughout its depth by so much as one-hundredth of a degreee from the freezing point, the formation of frazil does not depend on any considerable lowering of the temperature of the water. The formation of fine needles of ice all through the water of the river is probably aided by fine particles of sand and other suspended material acting as nuclei, since earthy matter is found embedded in the frazil attached to the under side of the surface ice.

In Section IV. (Geological and Biological Sciences), Sir William Dawson read a paper on fossil sponges and other organic remains from the rocks of the Quebec Group at Little Metis.—Prof. D. P. Penhallow read a paper which embodied his final deductions on the generic characters of the North American Coniferæ as exemplified in the microscopic structure of the woods.—Prof. Ramsay Wright gave the results of his studies of a great number of minute forms of life obtained from certain of the Canadian fresh-water lakes by means of a very fine tow-net, among which he describes a number of new species, and compares others with closely allied forms already recognised in the lakes of Scandinavia and other parts of Europe. He also communicated a paper by Mr. E. C. Jeffery, on the morphological nature of the medullate stellar structures of certain plants.—Dr. George M. Dawson, in a communication on secular climatic changes in British Columbia, showed from a study of the rainfall of the Province, as evidenced by the varying height of lakes without outlet, that the last few years have been more humid than any preceding them in a period of about fifty years.

Other papers were read by Prof. Edward E. Prince, Dr. A. R. C. Selwyn, Dr. William Saunders, and others.

The usual public lecture was delivered by Prof. Prince, Dominion Commissioner of Fisheries, on the fishery industries and resources of Canada.

The Society decided to petition the Dominion Government to establish a marine biological station at some point on the Atlantic Coast of Canada, as soon as possible, as recommended in a recent report of the Dominion Commissioner of Fisheries.

Prof. Ruttan and Prof. Adams, of McGill University, and Mr. W. Bell Dawson, of the Hydrographic Service, were elected Fellows of the Society, to fill three vacancies recently caused by death.

The meeting was well attended, and was successful in all respects. At the conclusion of the meeting the Fellows of the Society were entertained at a garden party, by their Excellencies the Earl and Countess of Aberdeen, at Rideau Hall.

THE CIRCULATION OF ORGANIC MATTER.

AT the evening meeting of the Royal Institution on Friday, April 24, Dr. G. V. Poore gave a discourse on the circulation of organic matter. Without attempting to define "organic matter," Dr. Poore began by saying that all organic matter was combustible, and that all our combustibles were of organic origin. A comparison was made between combustion in a furnace and the combustion of food in the body of an animal, and it was shown that whereas in the furnace the fuel was used up and furnace wore out, in the animal there was increase of size, while its droppings stimulate the soil to an increased production of food. This apparent increase was probably due to the holding in suspension by the extra growth of plants of both water and soluble salts, which otherwise would percolate the soil and find their way to the sea. Recent experiments made it certain, also, that some of the atmospheric nitrogen was appropriated by microbes in the soil. The animal was a true regenerative furnace, and led to the increase of the herbage at the expense of the sea on the one hand, and the atmosphere on the other. It was impossible to imagine an increase in one direction without some compensating decrease in another direction. When organic matter collected under water, fermentations were set up, and the organic matter was reduced instead of being oxidised. The tendency of organic matter, when thus treated, to form combustible bodies was very remarkable. The inflammable gases which sometimes formed in cesspools, and the marsh gas evolved by mud in ponds and rivers, were familiar examples, as were also the alcohols formed by the fermentation of carbohydrates. Our immense stores of coal and peat were due to the silting up of marsh plants in past ages and in recent times, and so-called mineral oils were certainly of organic origin, as were also the nitrates which were so much used in the manufacture of explosives. If we were to judge what *has been* by what *is*, it was impossible not to come to the conclusion that life must have preceded combustion in this world. This biological theory of the cosmogony made the world subject, like all other things, to the processes of development, evolution and decay, and he believed that such a theory had fewer drawbacks than might at first sight appear.

Organic matter was our capital in this world, and the more frequently we could make it circulate the greater would be our increase of material wealth. If we burnt it or threw it into the sea, we thereby spent money for dissipating our capital; but if we placed it on the land, we increased our capital and earned frequent dividends. The *rôle* of microbes in the soil, in bringing about the humification and nitrification of organic matter, was next dealt with. It was shown that farming without frequent additions of organic matter to the soil, must end in ultimate failure. We found everywhere that vegetable organisms co-operated with animals in the destruction and circulation of organic matter, and it appeared to be probable that the correlation of the biological forces was not less rigid than the correlation of the physical forces.

Allusion was made to the observations of M. Megnin on the destruction of animal bodies by successive squadrons of insects and microbes, and many facts were brought forward to show that the comparatively new doctrine of symbiosis was probably of universal application. The intestines of every animal swarmed with microbes which were essential for digestion, during life, and at death were active in starting the dead body upon the cycle of events which led to its ultimate circulation and re-

appearance in plant form. There were no less than 628 species of fungi which flourished in excrement, and of these no less than 402 were peculiar to certain animals. There could be no doubt the excrement often contained the organisms which led to its dissolution and circulation.

The proper course to pursue with organic matter was to place it near to the surface of well-tilled ground, and such a course seemed to be both profitable and safe. By mixing it with water we had all the evils of putrefaction, while our capital was thrown into the sea, and our water-supplies were poisoned by leakage. Our methods of sanitation inevitably lead to overcrowding, and farmers were often taxed to provide expensive apparatus, which merely deprived them of organic matter which otherwise might fertilise the land instead of involving them in a ruinous expense.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Some friends of the late Prof. Sir T. F. Wade have offered to the University, by way of memorial, a sum of £100 for the construction of a catalogue of the Chinese books in the University Library. These books were his own gift, and during his lifetime he held the post of Honorary Curator of the collection.

Mr. J. E. Gray, and Mr. S. D. Scott, of King's College, have been appointed to work at the University's table in the Zoological Station of Naples and Plymouth respectively.

Sir Walter Gilbey has offered to the University a fund sufficient to provide an income of £25 a year for twenty-one years as an endowment for a Lecturer in the History and Economics of Agriculture. The Council of the Senate recommend that the benefaction should be gratefully accepted, and propose suitable regulations for the foundation of a "Gilbey Lectureship."

The Library Syndicate propose that the new class of "Advanced Students" should have the same privileges as Bachelors of Arts in respect of borrowing books from the Library.

The discussion by the Senate of the proposal to expend £27,000 in acquiring sites adjoining the congested area occupied by the New Museums was unusually full and detailed. The price is generally held to be high, but the importance of the ground in question for the extension of the scientific and other departments was strongly urged. The question is to be decided by a vote to-day.

In the Mathematical Tripos, Part I., all but one of the candidates have obtained honours. Fourteen women are among the successful. The class list will be published on June 16.

The Deputy-Professor of Pathology, Dr. A. A. Kanthack, announces four courses of instruction in different branches of his subject, including bacteriology, during the ensuing Long Vacation (July and August).

Honorary degrees are to be conferred on June 18 on a number of foreign men of letters, and upon Prof. Carl Gegenbaur, of Heidelberg, Prof. Felix Klein, of Göttingen, and Prof. Simon Newcomb, of Johns Hopkins University, Baltimore.

Mr. Charles Smith, Master of Sidney Sussex College, has been re-elected Vice-Chancellor.

"THE College of New Jersey," universally known as "Princeton," has just changed its corporate name to Princeton University. An attempt will be made to raise 2,000,000 dols. in connection with its approaching sesqui-centennial celebration this fall. John I. Blair has contributed 150,000 dols. for a dormitory to be known as Blair's Hall, and another friend has contributed 100,000 dols.

THE Council of Firth College and the Committees of the Medical School and Technical School, Sheffield, have each passed resolutions in favour of a joint application for a charter of incorporation with the Victoria University, Manchester. A meeting of representatives from these educational establishments has been held, at which the form of the proposed charter was finally agreed upon, and a small Committee appointed to bring it before the proper authorities.

A RESOLUTION was moved at the last meeting of the Technical Instruction Committee of the Glamorganshire County Council to the effect that funds should be allocated to the establishment of five musical scholarships, each of the value of £40 per annum, tenable at the University College, Cardiff. The resolution was not seconded. It was decided to defer the matter until the next meeting. The two issues which are here raised, (1) whether the funds for technical instruction can rightly be devoted to musical education, and (2) whether it is desirable to encourage such instruction at a University College, certainly require some time for consideration.

SCIENTIFIC SERIALS.

The Quarterly Journal of Microscopical Science for May 1896 (vol. xxxix. part 1) contains:—On the blood of Magelona, by Dr. W. Blaxland Benham (pl. 1). The blood of *Magelona papillicornis* is totally different in structure from that of any other known Chætopod, in that it consists mainly of very small madder rose-coloured, non-nucleated globules, embedded (rather than floating) in a very small amount of colourless plasma; amongst the corpuscles occur isolated nuclei. It was originally demonstrated by Lankester that nuclei occur in the red fluid of the common earthworm, and this observation has been extended to sundry other Annelids by various observers. In these cases, as in Megalona, the nucleus is surrounded by very little, if any, protoplasm, and floats freely in the perfectly liquid plasma, which is coloured red by hæmoglobin, or in a few cases green by chlorocruorin or chlorochromin; while in some Oligochætes the plasma is colourless. The so-called "corpuscles" or coloured globules of Magelona differ from those observed in other Annelids, not only in position, viz. within blood-vessels instead of in the cœlom, but also in structure and in their behaviour to chemicals. These globules "stand, as it were, midway between the coloured liquid plasma of Annelids generally and the coloured corpuscles of mammalian blood." The colouring matter showed no absorption bands, when spectroscopically analysed.—Fission in Nemertines, by Dr. W. Blaxland Benham (pls. 2 and 3). The fact that many Nemertines break up into pieces when irritated is well known, but the phenomenon has received but little attention, nor does it seem to have been definitely ascertained whether it is a normal occurrence. From these researches it seems, however, proved that these pieces are gonads, thrown off from the male and female worms, about the time the sexual elements are mature. The species examined belonged to the genus Carinella, and was probably *C. linearis*, Montagu.—Studies on the nervous system of Crustacea, by Edgar J. Allen (pl. 4). IV. Further observations on the nerve elements of the embryonic lobster.—Notes on Oligochætes, with the description of a new species, by Edwin S. Goodrich (pls. 5 and 6). The author first describes a new species of Enchytræus, found in a garden at Weymouth, also near Oxford and London (*E. hortensis*); it is, when full grown, about 15 mm. in length, and milky white in colour, the anterior end being sometimes yellowish. The chetæ are in bundles of from three to four, generally three in the dorsal and four in the ventral bundle; they have a straight shaft and a hooked inner end; a small dorsal head-pore is found between the pro-stomium and the first segment. In a favourable light the cuticle is seen to be covered throughout with fine hair-like processes, similar to those described by the author in *Vermiculus pilosus*. Three kinds of cœlomic corpuscles are described as very characteristic of this worm: (*a*) amœboid; (*b*) oval corpuscles of the type so frequently met with in the Enchytræidæ, nearly twice as large as the amœboid, flattened oval in form, and filled with refringent granules; and (*c*) a third type of a discoid form, but the refringent granules, when they escape by rupture of the corpuscle wall, form a long thread of transparent homogeneous substance, closely coiled. These threads are possibly of an albuminoid nature.—On the development of *Lichenopora verrucaria*, Fabr., by Sidney F. Harmer (pls. 7–10). The author in a previous volume of this journal, from a study of Crisia, had suggested that embryonic fission would be found to be characteristic of the whole group of cyclostomatous Polyzoa. A chance discovery of large numbers of the colonies of *Lichenopora verrucaria*, Fabr., in all stages of development, has enabled him not only to show that this fission occurs here in an equally marked manner as in Crisia, but to discover some previously unsuspected phenomena in the life-history of *Lichenopora verrucaria*. Among these is the restriction of the production of an embryo to one or two of the oldest Zoœcia in the normal development.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 21.—"Helium and Argon. Part III. Experiments which show the Inactivity of these Elements." By Prof. William Ramsay, F.R.S., and Dr. J. Norman Collie.

To chronicle a list of failures is not an agreeable task; and yet it is sometimes necessary, in order that the record of the behaviour of newly-discovered substances may be a complete one. It is with this object that we place on record an account of a number of experiments made to test the possibility of forming compounds of helium and argon.

It will be remembered that in their memoir on Argon (*Phil. Trans.*, vol. clxxxvi., A), Lord Rayleigh and Prof. Ramsay described numerous experiments, made in the hope of inducing argon to combine, all of which yielded negative results. Two further experiments have been since made—again without success.

(1) The electric arc was maintained for several hours in an atmosphere of argon. A slow expansion took place. The resulting gas was treated with caustic soda and with a solution of ammoniacal cuprous chloride, and, on transference to a vacuum-tube, it showed the spectrum of argon along with a spectrum resembling that of hydrocarbons. Having to leave off work at this stage, a short note was sent to the *Chemical News* on "A Possible Compound of Argon." On resuming work after the holidays, the gas was again investigated, and, on sparking with oxygen, carbon dioxide was produced. But it was thought right again to treat the gas with cuprous chloride in presence of ammonia, and it now appeared that when left for a sufficient time in contact with a strong solution, considerable contraction took place, carbonic oxide being removed. There can, therefore, be no doubt that, although apparently all gas had been removed from the carbon electrodes before admitting argon, some carbon dioxide must have been still occluded, probably in the upper part of the electrodes, and that the prolonged heating due to the arc had expelled this gas and converted it into monoxide. It appears, therefore, certain that argon and carbon do not combine, even at the high temperature of the arc, where any product would have a chance of escaping decomposition by removing itself from the source of heat. It is hardly necessary to point out that such a process lends itself to the formation of endothermic compounds such as acetylene, and it was to be supposed that if argon is capable of combination at all, the resulting compound must be produced by an endothermic reaction.

(2) A product rich in barium cyanide was made by the action of producer gas on a mixture of barium carbonate and carbon at the intense temperature of the arc. This product was treated by Dumas' process so as to recover all nitrogen; and, as argon might also have entered into combination, the nitrogen was absorbed by sparking. All the nitrogen entered into combination with oxygen and soda, leaving no residue. Hence it may be concluded that no argon enters into combination.

(3) A mixture of argon with the vapour of carbon tetrachloride was exposed for several hours to a silent discharge from a very powerful induction coil. The apparatus was connected with a gauge which registered the pressure of the vapour of the tetrachloride and of the argon of which it was mixed. Careful measurement of the pressure was made before commencing the experiment, and after its completion. Although a considerable amount of other chlorides of carbon was produced, no alteration of pressure was noticeable; the liberated chlorine having been absorbed by the mercury present. Here again the argon did not enter into the reaction, but it was recovered without loss of volume.

The remaining experiments relate to attempts to produce compounds of helium. The plan of operation was to circulate helium over the reagent at a bright red heat, and to observe whether any alteration in volume occurred—an absorption of a few c.c. could have been observed—or whether any marked change was produced in the reagent employed. As a rule, after the reagent had been allowed to cool in the gas, all helium was removed with the pump, and the reagent was again heated to redness, so as, if a compound had been formed, to decompose it and expel the helium. Every experiment gave negative results; in no case was there any reason to suspect that helium had entered into combination.

A short catalogue of the substances tried may be given, none of which gave any signs of combination.

(4) Sodium.	(13) Thorium.
(5) Silicon.	(14) Tin.
(6) Beryllium.	(15) Lead.
(7) Zinc.	(16) Phosphorus.
(8) Cadmium.	(17) Arsenic.
(9) Boron.	(18) Antimony.
(10) Yttrium.	(19) Bismuth.
(11) Thallium.	(20) Sulphur.
(12) Titanium.	(21) Selenium.

(22) Uranium oxide, mixed with magnesium dust, was heated to bright redness in helium. No change, except the reduction of the oxide, took place. The mixture was allowed to cool slowly in the current, and the helium was removed with the pump till a phosphorescent vacuum was produced in a vacuum tube communicating with the circuit. The mixture was reheated, and no helium was evolved, not even enough to show a spectrum. The vacuum remained unimpaired.

It had been hoped that elements with high atomic weight, such as thallium, lead, bismuth, thorium, and uranium might have effected combination, but the hope was vain.

(23) A mixture of helium with its own volume of chlorine was exposed to a silent discharge for several hours. The chlorine was contained in a reservoir, sealed on to the little apparatus which had the form of an ozone apparatus. No change in level of the sulphuric acid confining the chlorine was detected after the temperature, raised by the discharge, had again become the same as that of the room. Hence helium and chlorine do not combine.

(24) Metallic cobalt in powder does not absorb helium at a red heat.

(25) Platinum black does not occlude it.

(26) It is not caused to combine by passage over a mixture of soda-lime and potassium nitrate heated to bright redness. This was hardly to be expected, for it resists the action of oxygen in presence of caustic soda, even when heated by the sparks which traverse it.

(27) A mixture of soda-lime and sulphur consisting of polysulphides causes no change of volume in a current of helium passed over it at a bright red heat.

(28) Induction sparks in an ozone apparatus passed through a mixture of helium with benzene vapour in presence of liquid benzene for many hours, gave no change of volume. The benzene was, of course, altered, but the sum of the pressures of the helium and the benzene-vapour remained as at first. Had helium been removed, contraction would have occurred.

This ends the catalogue of negative experiments. Any compound of helium capable of existence would probably be endothermic, and the two methods of producing endothermic compounds, where no simultaneous exothermic reaction is possible, are exposure to a high temperature, at which endothermic compounds show greater stability, and the influence of the silent electric discharge. These methods have been tried, so far in vain. There is, therefore, every reason to believe that the elements, helium and argon, are non-valent, that is, are incapable of forming compounds.

Chemical Society, May 21.—Mr. A. G. Vernon Harcourt, President, in the chair.—The following papers were read. The diphenylbenzenes, I. Metadiphenylbenzene, by F. D. Chattaway and R. C. T. Evans. Metadiphenylbenzene may be prepared by the action of melted sodium on a boiling xylene solution of metadichlorobenzene and chlorobenzene; it melts at 84°.—Derivatives of camphoric acid, by F. S. Kipping. A lactonic monocarboxylic acid, $C_{10}H_{14}O_4$, which the author terms trans-π-camphanic acid, is obtained by boiling sodium π-bromocamphorate with water; its cis-isomeride can only be prepared as a salt. On oxidising trans-π-camphanic acid, transcamphotricarboxylic acid $C_{10}H_{14}O_6$ is obtained; on fusion with potash it yields the isomeric ciscamphotricarboxylic acid.—On some substances which exhibit rotatory power both in the liquid and crystalline states, by W. J. Pope. Cis-π-camphanic acid and transcamphotricarboxylic acid possess the power of circularly polarising light, both in the dissolved and crystalline state; in the former case the circular polarisation in the crystalline state is a specific property of the crystalline structure, but in the latter it is due to complicated twinning of the crystals.—Dimethoxydiphenylmethane and some of its homologues, by J. E. Mackenzie. Dimethoxydiphenylmethane, and the corresponding diethoxy- and dibenzoxy-compounds, may be prepared by the interaction of benzophenone chloride and the sodio-derivative of methylic, ethylic or benzylic alcohol respectively.

Zoological Society, June 2.—F. DuCane Godman. F.R.S., Vice-President, in the chair.—Mr. Sclater exhibited the skin of an African Monkey of the genus *Cercopithecus*, originally received alive from Mombasa, which he believed to be referable to Stairs's Monkey (*C. stairsi*).—Mr. Sclater also exhibited a series of water-colour drawings of African antelopes by Mr. Caldwell, and a photograph of the gorilla now living in the Society's Gardens, by Mr. Henry Scherren —A communication was read from Mr. Henry J. Elwes and Mr. Edwards, containing a revision of the European and Asiatic butterflies of the family Hesperiidæ. The species treated of in this paper were about 450 in number and were divided into about 100 genera.—Mr. Charles Davies Sherborn gave an explanation of the plan he had adopted in his "Index Generum et Specierum Animalium." Mr. Sherborn stated that the absence of any trustworthy lists of the species of particular genera had led him to commence the compilation of an "Index Generum et Specierum Animalium" in 1890. Since that time 130,000 generic and specific names had been recorded in a manuscript which was stored at the British Museum (Natural History). Mr. Sherborn explained in detail the method and plan adopted for the compilation of the work.—Mr. G. A. Boulenger, F.R.S., read a paper on the dentition of snakes, and added remarks on the evolution of the poison-fangs in this order of reptiles.

PARIS.

Academy of Sciences, June 1.—M. A. Cornu in the chair.—The President announced the loss sustained by the Academy by the death of M. Paul Daubrée, Member of the Section of Mineralogy. A letter from M. Des Cloizeaux, giving a brief account of M. Daubrée's contributions to science, was read by the Secretary.—Note on the observed passages of Mercury across the disc of the sun, and on the question of the existence of inequalities of long period in the mean longitude of the moon, of which the cause is still unknown, and in the rotation of the earth upon its axis, by M. S. Newcomb.—On the laws of induction. Reply to the note of M. Marcel Deprez, by M. A. Potier.—Action of acetylene upon iron, nickel, and cobalt reduced by hydrogen, by MM. H. Moissan and Ch. Moureu. If acetylene, which has been allowed to suddenly impinge upon pyrophoric iron which has been reduced by hydrogen at the lowest possible temperature, the gas is decomposed with incandescence into its constituents. At the same time, owing to the high temperature, condensation takes place, and a liquid hydrocarbon, rich in benzene, is produced. The same phenomenon is produced by pyrophoric nickel and cobalt, and also by platinum black. No compound containing metal can be isolated, and the decomposition appears to be due to physical causes.—Respiratory exchanges, in the case of muscular contractions provoked electrically in animals either fasting, or fed with a diet rich in carbohydrates, by MM. A. Chauveau and F. Laulanie. The experimental results with dogs and rabbits were identical with those already obtained with men.—New experiments on the distribution of velocities in tubes, by M. Bazin. No single expression can be given which will accurately represent the velocity of an air current at any point between the centre and circumference of the tube, the law being very complicated. At a distance from the centre equal to three-fourths of the radius of the tube the velocity was equal to the mean for the whole tube.—On a musical register, by M. A. Rivoire. Description of an instrument for automatically recording the notes struck on a piano.—Density of variable stars of the Algol type, by M. Mérian. Starting with the hypothesis that the variations in the brightness of stars of the Algol type are due to eclipses produced by dark satellites, a formula is developed giving the density in terms of constants that can be experimentally determined.—On entire functions, by M. Hadamard.—On systems in involution of equations of the second order, by M. E. Goursat.—On a differential equation of the first order, by M. Michel Petrovitch.—On the rotation of a variable body, by M. L. Picart.—On the anomaly in the acceleration of gravity at Bordeaux, by M. J. Collet.—On the theory of turbines, pumps, and centrifugal fans, by M. A. Rateau.—On molybdenite and the preparation of molybdenum, by M. M. Guichard. Metallic molybdenum free from sulphur can be obtained by subjecting the mineral molybdenite in a carbon tube to the electric furnace (900 amperes, at 50 volts) for five minutes. The ingot contained about 92 per cent. of molybdenum, 2 per cent. of iron, and 7 per cent. of carbon.—On the methylamines, by M. Delépine. As a means of distinguishing the three methylamines rapidly and with certainty, the formation of the picrates is recommended, the salts from mono-, di-, and trimethylamine melting respectively at 207°, 156°, and 216°, and differing also in colour and solubility.—On the reaction between aldehydes and phenylhydrazine, by M. H. Causse. Compounds are obtained with acetaldehyde and benzaldehyde which appear to contain one molecule of aldehyde to two of phenylhydrazine, and to be formed without any condensation.—On a new building material from glass refuse, by M. Garchey.—On the influence of certain pathological agents on the bactericidal properties of the blood, by M. E. S. London.—On the slowness of the normal coagulation of the blood in birds, by M. C. Delezenne. Contrary to the generally accepted view, if the blood of birds is taken under experimental conditions similar to those in general use for mammals, the coagulation always takes place with extreme slowness, frequently not commencing until four to six hours after its removal from the artery.—On a new audiometer, and on the general relation between the intensity of the sound and the successive degrees of sensation, by M. Charles Henry.

BOOKS RECEIVED.

BOOKS.—Crystallography for Beginners: C. J. Woodward (Simpkin).—Crystals and Apparatus for use with ditto (Simpkin).—Chemistry in Daily Life: Dr. Lassar-Cohn, translated by M. M. P. Muir (Grevel).—The Spas and Mineral Waters of Europe: Drs. H. and F. P. Weber (Smith, Elder).—The Antichrist Legend: W. Bousset, translated by A. H. Keane (Hutchinson).—Lloyd's Natural History. British Birds: R. B. Sharpe, Part 1 (Lloyd).—Théorie Nouvelle de la Vie: Dr. F. Le Dantec (Paris, Alcan).—Stuttering and how to cure it: L. Klindworth (Glasgow, Bauermeister).—A Manual of Botany: Prof. J. R. Green, Vol. 2 (Churchill).—The Pathology of the Contracted Granular Kidney: Sir G. Johnson (Churchill).—Animals at Work and Play: C. J. Cornish (Seeley).—Physikalisch-Chemische Propaedeutik, Zweite Hälfte, 1 Liefg. (Leipzig, Engelmann).—Lehrbuch der Vergleichenden Mikroskopischen Anatomie der Wirbeltiere: Dr. A. Oppel. 1 Teil. Der Magen (Jena, Fischer).—Geological Sketch Map of South Africa, and Notes on the Geological Formation of South Africa and its Mineral Resources: F. P. T. Struben (Stanford).

CONTENTS.

THURSDAY, JUNE 18, 1896.

THE EVOLUTION OF COUNTING.

The Number Concept: its Origin and Development. By Levi Leonard Conant, Ph.D. 8vo. Pp. 218. (New York and London: Macmillan and Co., 1896.)

PROF. CONANT has produced a book which supplies a gap in scientific literature, and on it he has expended great diligence in collecting the materials, and circumspection in dealing with them. The problems of the origin and development of the number concept are important alike to the anthropologist and the psychologist, and all attempts to connect these two branches of science are most welcome; for the scope of the book, therefore, and for its execution, Dr. Conant is to be congratulated.

In a few instances, languages have been found to be absolutely destitute of pure numeral words; the Chiquitos of Bolivia, for example, expressed their idea for one by *etama*—"alone"—they had no real numerals. A few other South American languages are almost equally destitute of numeral words, but some indirect expression shows a conception of the difference between 1 and 2, or, at least, between 1 and many.

There is a surprising paucity of numeral words among the native races of South America, Australia, New Guinea, and among the Pigmy peoples. Many of these have only two numerals. It is probably true that no Australian language contains a pure, simple numeral for 4; a few tribes have a numeral for 3. The same obtains for the Papuan as opposed to the Melanesian tribes of British New Guinea, whereas the numerals of the latter S. H. Ray, *Trans. Internat. Congr. Orientalists*, London, 1892–93, p. 770) have decided affinities with those of the Melanesian archipelagoes. It is also characteristic of the Australians and the Papuans (as here restricted) to count by pairs; but this is not a Melanesian custom, though it is employed in Polynesia. The Mincopies (Andaman Islands) and the Veddas have numerals for only 1, 2, beyond which they say "and one more, and one more," &c.; for the Bushmen, 3 means simply many. The Pigmies of Central Africa, according to Stanley, have separate numerals up to 6, but the words for 1 (*ujju*) and 6 (*ijju*) are so closely akin, that it suggests that 6 was to them a new 1. These Pigmy people are considerably in advance of the others just referred to, so far as their system of numeration is concerned.

The author carefully points out that it is not a general law that those races which are lowest in the scale of civilisation have the feeblest number sense or the least possible power of grasping the abstract idea of number. If the life of any tribe is such as to induce trade and barter, a considerable quickness in reckoning will be developed among them. In giving 1, 2, 3, 5, 10, or any other small number as a system limit, it must not be overlooked that this limit mentioned is in all cases the limit of the spoken numerals at the savage's command. The actual ability to count is almost always, if not always, somewhat greater than their vocabularies would indicate. By means of their fingers, toes, or other parts of their body, or by the aid of sticks and other objects, the savages with even the lowest number concept can indicate higher numbers than their spoken numbers. Most proceed with more or less readiness as far as their fingers will carry them, and this limit is frequently extended to 20.

The primitive savage counts on his fingers until he has reached the end of one, or more probably of both, hands. Then if he wishes to proceed further some mark is made, a pebble is laid aside, a knot tied, &c., to signify that all the counters at his disposal have been used. Then the count begins anew, the terms already used are again resorted to, and the name by which the first halting-place was designated is repeated with each new numeral; hence *thirteen*, *fourteen*, &c. In Teutonic languages the smaller number is prefixed to the base, *e.g.*, *fünf und zwanzig*; but the direct method (*twenty-five*) is far more common, though both are found in all parts of the world.

The formation of numeral words by subtraction, though it seems decidedly odd to us, is of common occurrence. In Latin, 19 is *undeviginti* (1 from 20); the Bellacoola, of British Columbia, say for 19 "one man less 1," as in their numeral scale 20 is "one man," for them 15 is "one foot," and 16 "one man less 4." Many tribes seem to regard 9 as "almost 10," and to give it a name which conveys this thought.

The following Zuñi scale is interesting:—

1, "taken to start with."
2, "put down together with."
3, "the equally dividing finger."
4, "all the fingers but one done with."
5, "the notched off."
6, "another brought to add to the done with."
7, "two brought to and held up with the rest."
8, "three brought to and held up with the rest.
9, "all but all are held up with the rest."
10, "all the fingers."
11, "all the fingers and another over above held."
20, "two times all the fingers."
100, "the fingers all the fingers.

1000, "the fingers all the fingers times all the fingers."

While the savage almost always counts on his fingers, it does not seem at all certain that these words would necessarily be of finger formation. The numerals for 1 and 2 would be formed long before the need would be felt for terms to describe any higher number. Universal as finger counting has been, finger origin for numeral words has by no means been universal. In nearly all languages the origin of the words for 1, 2, 3, and 4 are so entirely unknown that speculation respecting them is almost useless.

The first real difficulty which the savage experiences in counting, the difficulty which comes when he attempts to pass beyond 2, and to count 3, 4, and 5, is of course slight. Beyond 5, primitive man often proceeds with the greatest difficulty. Whenever the fingers and hands are used at all, it would seem natural to expect for 5 some general expression signifying *hand*, for 10 *both hands*, and for 20 *man*. Such is the ordinary method of progression, but some people express 10 by *man*, perhaps because they do not use the toes in counting; thus the Api word for 200 is "10 times the whole man taken 2 times."

Without the establishment of some base, any system of numbers is impossible. A binary system is characteristic of Australia, but it occurs elsewhere; instances of quaternary numeration are less rare than are those of ternary, and there is reason to believe that this method of counting has been practised more extensively than any other, except the binary and the three natural methods—the quinary, the decimal, and the vigesimal. There is probably no recorded instance of a number system formed on 6, 7, 8, or 9 as a base.

In its ordinary development the quinary system is almost sure to merge into either the decimal or the vigesimal system, and to form with one or the other, or both of these, a mixed system of counting. Whether or not the principal number base of any tribe is to be 20, seems to depend entirely upon a single consideration—are the fingers alone used as an aid to counting, or are both fingers and toes used? If the former, the resulting scale must become decimal. The quinary is never the principal base in any extended system. The Celtic races showed a preference for counting by twenties, which is almost as decided as that manifested by the Teutonic races for counting by tens.

With such a vast field from which to collect materials for his study, it is inevitable that Prof. Conant should have overlooked some authors who might have furnished him with additional examples, and that he should have made a few slips. Among the omissions may be noted Dr. Von den Steinen's discussion on the numeration of the Bakaïri in his "Unter den Naturvölkern Zentral-Brasiliens," Mr. Ray's studies in the languages of New Guinea, Mr. H. Clifford's account of the Negritos of the Malay Peninsula (*J. Roy. As. Soc. Straits Br.*, 1892), Dr. S. Günther's study on numerical systems (*Beitr. Anth. Urgesch. Bayerns*, 1890, ix.). On p. 96 the Torres Islands in the New Hebrides are confused with Torres Straits, and the languages of Darnley Island (p. 24) and Warrior Island (p. 107) are Papuan (Torres Straits), and not Australian dialects. Anthropologists would have been thankful if the ethnological aspect of the question had been dwelt upon a little more fully; for example, the ethnologist is not at a loss to account for the superior development of the number sense in the Nicobarese as compared with that of the neighbouring Andamanese. The book is admirably printed, and is packed with valuable information clearly and logically arranged.

A. C. HADDON.

GEOMORPHOGENY.

Leçons de Géographie physique. Par Albert de Lapparent. Pp. xvi. + 590. Illustrations. (Paris: Masson et Cie., 1896.)

If Prof. de Lapparent had been writing in America, he would have introduced the word *Geomorphogeny* in the title of his latest book; but in Europe, he observes in the preface, there is some risk of frightening those whom he would wish to instruct if they are confronted by an unfamiliar term at the outset The title "Lessons in Physical Geography," although quite without terror, is not fairly descriptive, for this fine volume is no ordinary treatise of physical geography in the usual vague sense. "Lessons on the Genesis of Geographical Forms" would, in the author's view, and in ours, be more descriptive; but the full scope of the work would, perhaps, hardly be suggested even by such a title.

Whatever he may call it, a book by Prof. de Lapparent is sure of a cordial reception by students and men of science in all parts of the world, for he combines the traditional grace and charm of French scientific writers with a temperateness of judgment and width of view which, rightly or wrongly, foreigners do not always associate with the writings of his countrymen. The avowed object of the work is to furnish a body of doctrines, logically linked together, which shall help to place geography on a truly rational basis. This basis is, in Prof. de Lapparent's opinion, a geological one, for he argues that the knowledge of no geographical form can be complete unless its antecedent conditions are known, and in geology alone can the clue to these be found. We might perhaps demand an even deeper foundation than geology, by taking into account the relations of form and position and the means of determining these mathematical conditions by astronomical observations: but geology may be freely accepted as the layer in the pyramid of geographical science which comes immediately below physical geography, and is most indissolubly connected with it.

The volume takes the form of twenty-five "lessons" or chapters; but it may be divided into two parts, approximately equal in bulk—the enunciation of the general principles of geomorphogeny, and the application of these to the configuration and structure of each of the continents. The great lines of terrestrial relief are first outlined, and the conditions of land-modelling are then discussed in fuller detail and with a more comprehensive grasp than in any other book of the kind with which we are acquainted. The various agencies at work on the land-surface are treated in turn, and their action illustrated by a great wealth of instances. The normal course of erosion in a region is first explained, and the various complications introduced by structural conditions, classed as genetic and tectonic, are then introduced. Genetic conditions are those produced by the original formation of the portion of land under consideration, *e.g.* whether sedimentary, igneous, or glacial; tectonic are those subsequently produced by movements of the crust. Considering the predominant part played in the modelling of the land by running water, it is natural that several lessons should be devoted to this agency, in the discussion of which a prominent place is given to the view of the cycle of erosion so vigorously set forth of recent years by Prof. W. M. Davis, of Harvard. One can hardly say of any part of this theory that it is new. Geologists have worked so long at the phenomena of erosion, that it is now difficult to fit each stage of the process with the name of the first observer or theoriser. But there is no doubt that, however universally the knowledge of the processes of the origin of scenery by denudation were known, the credit for expressing the nett result of them in terse and appropriate language is due to Prof. Davis, and his mode of statement is accepted by Prof. de Lapparent with full acknowledgment. The conception of the origin of surface features through a process of evolution, a continuous succession

of adaptations to environment, is clearly stated; and the view of a land-surface modelled by the action of its rivers, and passing through the consecutive stages of adolescence, maturity, old age, and decrepitude, with a possible rejuvenescence by partial upheaval during the later stages, is set forth in an attractive manner. This is perhaps the nearest approach to a theory of physical geography which has yet been advanced, and the results of applying it serve to invest with fresh interest the monotonous topography of regions which, having run their course of natural life, await in the condition of a "peneplain" the revivifying tectonic power which will start their old sluggish rivers into fresh activity, throwing them out of harmony with their surroundings, and setting them to work to dig, carry, and build until they have created a new land, and, as is the way of the world, again destroyed it.

Looking on a river as an individual, or rather as a living system, any change in one part is shown to affect the whole. For example, the slow cutting down of the outlet of a lake, the surface of which serving as a base-level has dictated the configuration of the country above, lowers the level, accentuates the upper slopes, quickens the tributaries one by one, causing them to erode their valleys more vigorously, and in time perhaps to work back and tap the affluents of some other system, reversing their flow and extending the sphere of the power of the main river. The continual adaptation of river to land may in large measure be taken as the key to the origin of scenery in regions of normal drainage.

Prof. de Lapparent does not view aqueous erosion as all-powerful; he gives great weight to tectonic changes in preparing the way and laying down the lines along which erosion is to act, as, for example, in outlining the depressions of fjord and lake valleys. To glaciers he assigns a comparatively humble place: they cannot dig, but they are excellent polishers, and inexhaustible carriers; while if they cannot make valleys, they may at least preserve them unfilled for future occupation by lakes. The treatment of regions of internal drainage with their arid climates and characteristic æolian land-forms is particularly good.

We cannot, of course, attempt to summarise here a volume of six hundred pages, in which there is a steady unfolding of a definite plan supported by innumerable examples. It is only possible to allude to the chief contents. After the geomorphogenic introduction, two lessons are given to geological principles and their application in palæogeography, or the reconstruction of the map of the world in past ages. This introduces the systematic description of Europe, and of the other continents in less detail, from the point of view of the origin of their land-forms. Although necessarily in general terms, the description is sufficiently full to give a fair idea of the origin of all the more striking features of mountain and plain, and the general hydrographic system. There are points which might be criticised in detail; for example, one of the most important features in the existing geography of Scotland—the 25-foot raised beach which forms the sites of almost all the coast towns, both on the east and west—is not mentioned, but the larger features are very clearly described.

The work of M. de Lapparent builds largely upon the foundations of Suess, Penck, Richthofen, and numerous British and American geologists whose contributions to knowledge are carefully acknowledged. It is emphatically a book for teachers and for students of geography; a model of strong and clear reasoning in the elaboration of a theory where no theory was generally recognised before, and a rich storehouse of facts and references full of suggestiveness, and affording evidence of the widest reading and the most careful thought.

HUGH ROBERT MILL.

THE RESEARCHES OF NEWELL MARTIN UPON THE HEART AND RESPIRATION.

Physiological Papers. By H. Newell Martin. Reprinted as Memoirs from the Biological Laboratory of the Johns Hopkins University. III. 4to. Pp. 264. (Baltimore: Johns Hopkins Press, 1895.)

THE Johns Hopkins University at Baltimore was founded in the year 1876, and Newell Martin left Cambridge, to the personal regret of all his English friends, to become the first occupant of the chair of Biology. This he held during seventeen years, in the course of which the department over which he presided grew from small beginnings to large and extensive laboratories fully furnished with apparatus, animals and privatdocents in the most up-to-date Teutonic style. In the summer of 1893, Prof. Martin was compelled by ill-health to resign his professorship, and in recognition of the value of his work, and as a token of their affection and esteem for him, his American friends and pupils have republished the scientific papers and some of the public addresses which were written and delivered by him during his tenure of the chair.

Most of the work done by Prof. Martin during this period is upon the action of the mammalian heart, and the papers upon this subject occupy nearly one half of the volume. As all physiologists know, Martin was the first to carry out with success experiments upon the action of the isolated heart of the mammal, most of our knowledge regarding the isolated heart having been derived from experiments upon cold-blooded animals. It was not to be expected that there would be any serious divergences in the mode of action of the heart in the two cases, and in fact the results which Martin and his pupils obtained regarding the effects of pressure of temperature and of drugs were such as might probably have been anticipated. Nevertheless it marked a distinct advance in what the Royal Society officially terms "natural knowledge" to have succeeded in determining these points in the mammal, and that Society set the stamp of its recognition upon the work by selecting one of the most important of these papers as the Croonian lecture for 1883.

The other researches relate exclusively to the mechanism of respiration in the frog and in the mammal. The peculiar character of the respiration in the former animal has always excited the interest of physiologists, and in more recent years it had been studied graphically by Paul Bert and Burdon-Sanderson. Martin subjected the normal respiratory movements in the frog to a careful examination, and arrived at con-

clusions of much interest. He was also able to show, both in the frog and mammal, the influence of the mid-brain upon those movements.

One of the most important pieces of work here recorded is that in which Martin experimentally determined that the internal intercostal muscles are expiratory in their function throughout their whole extent, thus finally settling a question which had divided physiologists ever since physiology was recognised as a science. This he was enabled to do not by experiments upon models, nor upon the cadaver, but by direct observation in the living animal; a method which will always remain the only satisfactory one for solving such problems.

The physiologists of this country owe a debt of gratitude to their American colleagues for having provided them in so handsome a form with this important collection of monographs. E. A. Schäfer.

OUR BOOK SHELF.

Atlas d'Ostéologie. Articulations et Insertions Musculaires. By Prof. Ch. Debierre. Pp. viii + 92. (Paris: Alcan, 1896.)

This atlas contains 88 plates with 251 figures illustrating the human skeleton. Figures are also given to illustrate the ligaments of the various joints, and, further, for each bone the muscular attachments are indicated by red printing. The mode of development and microscopic of bone are illustrated by five figures, and in a few cases a certain amount of comparative osteology is introduced. The figures are by no means better than those given in the standard text-books, and it is a pity that no mention is made in each case of the amount of reduction or magnification made in the drawing. Some of the figures are very confused, and the individual parts difficult to recognise. This is especially the case with such figures as the base of the skull with the soft parts left attached (Fig. 82). In many cases it seems a mistake that the figures have not been drawn on a larger scale, as much room is often wasted on the plates.

Mechanics for Beginners. By W. Gallatly, M.A. Pp. 253. (London: Macmillan and Co., Ltd., 1896.)

The special characteristics of this book are stated to be (1) the large number of examples—eight hundred—of which one hundred and sixty are worked in full; (2) the great attention given to work, power and energy; (3) the classification, in small sections, of problems of the same type, the method of dealing with each section being explained by a worked example. Teachers of elementary theoretical mechanics will know how to appreciate these important qualities of the book. The descriptions are very clear, and the diagrams are helpful. The student who uses the treatise as a text-book, familiarising himself with the illustrative examples, and working through only a part of the well-selected and comprehensive exercises, will be equipped for almost any examination in elementary theoretical mechanics. And he will, at the same time, lay up in his mind a fund of useful knowledge.

Engineer Draughtsmen's Work. By a Practical Draughtsman. Pp. 96. (London: Whittaker and Co., 1896.)

Students in technical schools will find in this book a number of valuable hints on the use of mathematical instruments and the work of drawing-offices. The information is very elementary, but its character is such that it will train young draughtsmen to be accurate and methodical in their work.

Forty-eight pages of advertisement are bound up with the ninety-six pages of text.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Flying Engines.

In the summer of 1893, I made some experiments on the effect of steam-jacketing small steam-engine cylinders by placing the whole of the cylinder and valve chest inside the boiler; the increase of economy was so marked, that I was led to try whether a small toy engine could be made to sustain its own weight in the air by the lifting power of an air screw on the crank-shaft.

Fig. 1 shows this little engine. The boiler is of seamless steel $2\frac{1}{2}''$ diameter, $14''$ long, and $\cdot01''$ to $\cdot015''$ in thickness; the steam cylinder, single acting, $1\frac{1}{4}''$ diameter by $2''$ stroke, and about $\cdot03$ thickness of tool steel; the piston is of thin cup form, also of tool steel; the admission valve is cylindrical, $\frac{6}{16}''$ diameter, cutting off at $\frac{3}{4}$ stroke. The whole of the valve and cylinder are within the boiler. Some parts of the engine were soft soldered, and some hard soldered; the screw is of cane covered with silk. The working pressure was limited to about 50 lb. per square inch. The total weight of the apparatus, with water, as in Fig. 1, is $1\frac{1}{4}$ lb.

Fig. 1.—Steam engine and boiler working lifting screw; large plane to prevent rotation of boiler; total weight $1\frac{1}{4}$ lb. I.H.P. developed, $\frac{1}{4}$. Raised itself about 12 feet in the air, with steam contained in boiler. No firing after start. Initial pressure 50 lb. Maximum revolution about 1200 per minute.

Steam was raised by placing the boiler over a spirit-lamp, and when 50 lb. was registered on the gauge, and the engine started, it raised itself in the air vertically to a height of several yards. The revolutions of the engine were about 1200 per minute, and the i.h.p. $\frac{1}{4}$ horse-power.

The same engine was then mounted on a framework of cane, covered with silk, forming two wings of 11 feet span, and a tail, the total area being about 22 square feet. The total weight was now $3\frac{1}{2}$ lb., and when launched gently from the hand in an inclined horizontal direction it took a circular course, rising to a maximum height of about 20 feet. When the steam was exhausted, it came down, having traversed a distance of about 100 yards.

Fig. 2 shows the machine in mid-air. The photographs were taken by Mr. Gerald Stoney.

Considering the primitive construction of the apparatus, the result clearly showed that flights of considerable distance, possibly some miles, were quite possible with a small economical steam-engine mounted on aeroplanes.

The boiler was also found to be able to steam the engine continuously by using methylated spirits intead of water in the boiler,

and burning the exhaust as fuel; but when in flight, the force of the wind extinguished the flame.

It was clearly seen by the experiment that for practical commercial success of this class of steam apparatus an air condenser is essential, as the weight of water used in a few minutes' run

FIG. 2.—Same engine and boiler as before, attached to two inclined wing planes, and tail. From tip to tip of wings 11 feet; total surface of wings and tail about 22 square feet. Total weight of whole apparatus 3½ lb. Steam raised to 50 lb. per square inch, and started. Length of flight about 100 yards on level; maximum height during flight, about 20 feet. The propelling screw is seen in front and above the frame.

equals the total weight of engine and boiler. Without a condenser, the length of flight must necessarily be limited to a very few miles, and it would seem that the chief problem that workers in this field have to solve, is to obtain an efficient and light dry air condenser. CHARLES A. PARSONS.

Heaton Works, Newcastle-on-Tyne.

Experiments on Röntgen Rays.

AFTER examining the fluorescent and photographic action of the rays (X_2) emitted on strongly *heating* a "focus tube," and finding them different to the rays which have been hitherto noticed (X_1), in that the relative transparency of flesh, bone, aluminium and glass differs for the two kinds of rays, it seemed desirable to try the effect of cooling the tube. Solid carbon dioxide and ether, and then solid carbon dioxide alone were employed, with the result that in both cases the fluorescence of screen and tube very rapidly died out and the current apparently failed to pass through the latter; as the tube gradually grew warm again, the fluorescence in it returned, not gradually, but very suddenly, at a temperature not very far below that of the room, the glass lighting up brilliantly, and the shadows of the bones showing on the screen with increasing distinctness. The emission of X_1 rays reaching a maximum at about 12° C. (a rough guess). On further heating X_2 rays begin to be evolved, judging from the increasing opacity of the flesh, whilst at the same time the fluorescence excited on the screen grows rather brighter, until the state recorded in my paper of June 4, is reached. As the condition for the maximum of X_1 rays probably varies to a certain extent with the different forms of tube, and even different specimens of the same kind of tube, with the degree of exhaustion, &c., it seems to follow from these experiments that in some cases warming the tube slightly might be useful in photographing the bones, whilst in others moderate cooling would be better; and from the accounts of various operators such would seem to be the case, though, as will be seen in the light of subsequent experiments, the particular method of heating or cooling is an important factor in the result. Solid carbon dioxide seemed very opaque to the rays when its low density is considered, but the effect may have been partly due to the frost condensed upon it from the air.

Wishing to verify for myself the results of other experimentalists, I next examined the tube for its action on a well-insulated brass plate, at first by connecting it with a sensitive electroscope, and afterwards with one of the standard Thomson's quadrant electrometers. As the experiments were all carried out with great care, it may be worth while to state that, using thin aluminium plate well earthed by soldering to a gas-pipe to screen the plate from all ordinary inductive action, the results were that the rays after penetrating $\frac{1}{16}''$ of aluminium, discharged the plate completely, whether electrified positively or negatively, leaving no charge; and that if the plate were uncharged to begin with, it remained uncharged. This result is contrary to that observed by some; but from the delicacy of the instrument used, and the great distance between mirror and scale, there is little room left to doubt the accuracy of this result.

I also tried the effect on a radiometer, making similar experiments with a lampblacked Leslie's cube at about 94° C., and a candle, to see how far radiant energy from these sources was capable of penetrating the large aluminium screens used, in case any heat action might interfere with or mask the effect, and found, as others have, that when perfectly screened from all other action, the radiometer is entirely unaffected by the Röntgen rays, whether they be from a hot or a cold tube. The X-rays are also without action on the blackened face of a thermopile connected with a very sensitive galvanometer.

When the ordinary inductive effects of the tube were *not* screened, I found that the space external to the tube was at a high positive potential, which increased up to contact with the glass of the tube, and was of the same sign all over the bulb part. The cold bulb acted like a positively charged conductor whilst the discharge was passing, and attracted the radiometer arms just as any other charged body would, the effect lasting some time after the discharge stopped. The *unscreened* cold bulb also partly discharged the insulated plate, if the latter were strongly positively charged, it more rapidly discharged it when negatively charged, and left it with a positive charge of the same magnitude to begin with as that left when the plate was strongly positively charged, and lastly in the uncharged plate it developed a positive charge, again of the same magnitude; and this is what would naturally follow from the combination of the Röntgen rays effect with that of ordinary induction.

The X_2 rays seem to discharge a charged plate whether positively or negatively charged, but of this I cannot at present feel quite sure. Aluminium seems so far opaque to them that it is doubtful whether, when a screen is used, any of the rays get through, and when a screen is not used, one cannot feel certain that the effect observed is due to the X_2 rays either wholly or partly. After heating the tube and turning on the current, the whole tube is filled with a whitish, lavender-coloured light, which comes to a focus on the glass behind the kathode, above or below it; and whilst in this state and giving little or no fluorescence on the screen, the tube does *not* charge an *unscreened insulated plate*, but it does rather rapidly drain it of a previously communicated charge, either positive or negative. As the tube cools the lavender light retreats more and more from the kathode till at last it reaches the upper edge of the rectangular anode, when the positive charge, mentioned before, begins to be given to an uncharged insulated plate, but very slowly; as soon as the centre of the anode is bare of the lavender discharge, the potential of the unscreened plate very rapidly rises, and by the time the whole anode is clear of the lavender light the normal positive charge is re-established on the insulated plate. When the lavender glow retires from the kathode, it leaves behind it a space full of almost invisible light, which excites whitish green fluorescence on the glass of the bulb, and it is during this time that most of the rays are X_2, as is shown by the fluorescent screen, and photographs of a hand. I have not yet followed out the changes, relative and absolute, of potential of the anode and kathode, but it would seem almost certain that during the life of the lavender glow the whole tube acts as a relatively good conductor up to the time when the lavender glow crosses the centre of the anode—or the point where the axis of the kathode mirror cuts the anode, when there is an abrupt decrease in conductivity. I intend to investigate this point as soon as possible, and meantime pass on to what I imagine will prove of great use and interest to all who work with these tubes.

During some experiments on the tube with an 18" Wimshurst machine, I noticed that the X_1 rays, *i.e.* those showing the bones best, seemed to be emitted or not according as a brush discharge occurred on the wire leading to the anode of the tube, close to the tube, or not; and that the "electric wind" which blows from the tube as from all charged bodies, seemed also to vary in intensity with the X_1 ray flashes, the X_1 rays being most copiously emitted apparently at the moment when the brush discharge ceased or the wind moderated. I soon found that by making a small brush on the wire near the anode, or drawing

one with the finger from various parts of the tube (but not from all), best from the circular section of the tube in a plane with the edge of the kathode mirror, or in the very immediate neighbourhood of this line, the discharge producing the X_1 rays could be induced at will in a tube which was not otherwise giving them, or at any rate only giving them very feebly. Thinking, therefore, that the production of the X_1 rays must be in some way connected with intermittent leakage of the charge which resides on the outside of the tube (a continuous drain stops fluorescence and the emission of any rays capable of exciting my fluorescent screen altogether), I tried various ways of drawing off this charge intermittently, with several curious results; but the plan I find to work best is to place a ring of plain copper wire round the tube in the plane of the kathode mirror's edge, not touching the glass, but very near it, and then to cause a very rapid but intermittent discharge by bringing a wire connected to earth within a *very small* distance of some part of this ring, so far I cannot discover any particularly favourable position. The sparks between this ring and the earth wire are very small, but the effect on the fluorescent screen exceedingly striking.

What is still more interesting is that not only is the discharge of X-rays made much more regular (when the adjustment of the ring and wire is carefully made), but *the X-rays can thus be induced in a tube with a far weaker current;* the weakest current capable of inducing sparks between the ring and conductor seems capable of giving the X-rays, though they are more copiously emitted with a stronger current.[1] And not only so, but the tubes I have experimented with seem to show as yet no symptoms of growing fatigued. I have caused a brilliant emission of the X-rays from a tube which was before "fatigued"—at least, my coil seemed too weak to excite it, and the emission of X_1 rays has been sustained for over two hours with but a few short intervals, without showing any signs of diminution, judging by the screen effects; but on the withdrawal of the ring and wire, it at once failed to give any. This seems an important result, for it must greatly shorten the exposure and fatigue necessary for the photography of thick objects, and also greatly save the expense of the operations. Even breathing very gently, or blowing gently for a moment on the tube, specially on the parts mentioned, produces a marked bright flash which on examination will prove very rich in X-rays (a fact first noticed by Mr. P. H. Walter, my assistant). It would seem to follow from this that the "fatigue" is not altogether due to the diminution of the number of free particles in the tube, but to a kind of polarisation in which the glass acts as the dielectric separating a negative charge inside from a positive outside, the X-rays and fluorescence being dependent in some way on the oscillations consequent on the intermittent discharge of this condenser. I find that the tube also gives X-rays plentifully (though not so plentifully as when *both* terminals of the secondary circuit are used), when the positive terminal of the coil is connected in the usual way, and a wire from earth leads to what is usually the kathode; but only, so far as my experiments go, when the ring and other earthed wire are used. In this experiment the negative terminal was *not* connected with the earth, but insulated. The tube did not give X-rays, scarcely indeed any sign of the passage of electricity when the kathode wire only was retained in its usual position. The positive anode therefore seems in some respects to govern the emission of these rays.

In one experiment I placed a ring round the glass in the plane of the concave mirror of a Crookes' tube showing the "independence" of the positive pole from which I could not get any X-rays, and found on extracting a series of small sparks from it, with a wire leading to earth, a very decided increase in the still general fluorescence of the tube, but it gave no rays. Incidentally it was noticed that when a wire brush connected to earth was pressed lightly against the glass over the dark spot opposite the kathode, in every place touched by the wire, a most brilliant green fluorescence was excited, which faded away very quickly when the brush was withdrawn. It is therefore certain that much may yet be done to increase the efficiency of the tubes used for the production of X-rays by a further study of the action of neighbouring conductors upon them, and it seems that such a study cannot fail to throw light upon the cause of these hitherto unexplained phenomena.

Eton College, June 8. T. C. PORTER.

[1] I have succeeded in eliciting feeble X-rays from a Newton's focus tube with a small coil giving only 1/3rd of an inch spark—using the ring and earthed wire or finger.

Addendum, June 13.—After trying various forms of conductor, coating different parts of the X-ray tube with Dutch gold, and aluminium leaves, I find the following a most effective plan, and feel no hesitation in recommending it. First coat the external part of the tube between the kathode wire loop and the afore-mentioned plane of the edge of the kathode mirror, with any conducting metallic leaf; being careful that none of it projects beyond the trace of this plane on the glass of the tube. Next coil a stout piece of copper wire into a circular loop with a stem, and place it so that whilst the loop is in the plane of the edge of the kathode mirror, it does not touch either the glass of the tube or the metallic coating—I find an interval of about the $\frac{1}{20}$th of an inch answers excellently; and lastly, instead of using a wire to earth, bring the stem of the looped wire, or better still, a more pliable piece of wire connected with the loop stem, within a very short distance of the part of kathode wire from the coil close to the tube. The adjustment is easily made in practice, and the emission of X_1 rays which follows will, I think, be found satisfactory, to say the least, especially when it is remembered that without the looped wire the tube may be giving no X-rays at all.—T. C. P.

Koch's Gelatine Process for the Examination of Drinking-Water.

I DO not find that Dr. Percy Frankland advances any substantial evidence in his letter of May 12, in support of his broad and unqualified claim that he was the first person in this country who adopted the Koch method and applied it to the London water supply.

Dr. Percy Frankland states that he has "failed to find in Dr. Angus Smith's publications any mention whatsoever of cultivation on plates or their equivalents in any shape or form," and which he "holds to be the essence of the process which bears the name of Koch, and to which modern bacteriology is so profoundly indebted."

Now if Dr. Percy Frankland will turn to page 28 of Dr. Angus Smith's report to the Local Government Board, he will find Dr. Angus Smith writing as follows:—"It may be better to give up test-tubes entirely—equally good results have been obtained by using other vessels." As a matter of fact, photographic glass-plates were used in some of Dr. Angus Smith's experiments, also flat-bottomed flasks, desiccators, &c.; consequently if Dr. Percy Frankland's contention is correct, that the essence of the process which bears the name of Koch consists in the use of plates or their equivalents, Dr. Angus Smith at all events can be credited with having adopted the essence of the process. The main value, however, of Dr. Koch's invention was in the use of gelatine for preserving, as Dr. Angus Smith said, "the indications of organic vitality, and of affording an opportunity for the expansion of living germs in water, keeping a record for a time both of the quality and intensity of life in the liquid, and enabling the smallest points to exert their energies, and, as it were, to build their structures, the size and numbers of which can to some extent be measured and counted"

Dr. Koch was the first to use gelatine, and it was from him Dr. Angus Smith learned its use; for he says, "I seized on the use of gelatine with great earnestness, and soon satisfied myself that there was much to be gained by its use. . . . Dr. Koch has himself informed me that he is glad I have taken up the subject . . . a subject being more fully developed under Dr. Koch by Dr. Rozahegyi, and chemists must prepare for a new condition of things."

With regard to Dr. Percy Frankland's statement that Dr. Angus Smith distinctly deprecated rendering the medium more nutritive, I do not agree with it, inasmuch as Dr. Angus Smith clearly stated that "experience must discover whether this is an advantage . . . the use of sugar in addition to the gelatine renders the examination of water by this method less dependent on the opinion of the operator, and a photograph may be taken of each specimen, and the result preserved as evidence."

Whilst wishing in no way to detract from the value of the work which has been done by the use of the modified Koch's process, and from developments of bacteriological methods since the investigation of Dr. Angus Smith, I believe that I have quoted sufficient evidence to show that Dr. Angus Smith was the first chemist in this country who "seized on" and applied to practical purposes Dr. Koch's gelatine process of 1881; and his name will ever be associated with the historical development and application of Koch's gelatine process in this country; and

as the pioneer worker in the bacteriological method for the examination of drinking-water involving the use of solid culture material, viz. gelatine. FRANK SCUDDER.

Ellerslie, Alderley Edge, June 5.

A Prognostic of Thunder.

As the thunderstorm season has now set in, may I call the attention of weather observers to what seems to me an almost infallible prognostic of thunder, which was described in a letter in NATURE of July 5, 1888.

It consists in the formation of a small group of *parallel streaks* of cloud, seldom more than three or four in number, definite in form, and limited in extent and duration, appearing either as white streaks on the blue, or more rarely as darker streaks against nimbus or cumulo-nimbus.

I have very rarely seen these "parallel bars," as I have come to call them, without their being followed by thunder within twenty-four hours.

As the value of the prognostic seems to depend on the definiteness, small magnitude, and short duration of the "bars" (since one may sometimes see a large portion of the sky covered with rippling clouds which are followed only by rain without thunder, or not even by rain), their connection with thunderstorms seems to be explicable by the view that they are "interfret clouds" of very limited extent, indicating the superposition of atmospheric strata of very unequal temperature or humidity, with a *restlessness* which shows itself in local and temporary irruptions from one stratum into the other; an irregular condition very likely to be associated with electrical disturbance.

I may add that these "bars" are very readily detected after being once seen, and very easily noted; and they deserve, I think, more attention from meteorologists than they have received. B. WOODD-SMITH.

Hampstead Heath, N.W., June 10.

Tufted Hair.

I HAVE had, within the past few days, my first opportunity of examining closely the living head and hair of the African Negro, on several "Kru boys" from the West Coast. Their hair, which was cut moderately short, presented the usual appearance of a congeries of tufts arranged in a more or less linear manner, but when closely investigated it was found to be uniformly distributed over the scalp—each cork-screw tuft, resulting from the separate hairs on amall adjacent areas, intertwisting together and forming a silky compressed curl. In New Guinea I investigated the manner of growth of the hair on a large number of natives from widely distant regions, on many of whom the body was also covered with, to all appearance, little distinct spirals. On close scrutiny, and with a little trouble, these "cork-screws," both on head and body, could be perfectly uncurled and separated out into individual hairs growing from roots as nearly as possible equidistant from a central hair, round which the others coiled themselves, each hair being in fact a twining-plant-like structure, laying hold of a neighbouring hair as a supporting stake. Both on body and head the hair follicles were evenly distributed. These facts, as regards the African, are already quite well known from the investigations of Prof. Virchow and others; but it may not be without interest if I record, after this opportunity of comparing the Melanesian with the Negro, that the growth of their hair in both races is identical.

The Museums, Liverpool, June 14. HENRY O. FORBES.

LORD KELVIN.

AS these words are being printed, the Jubilee of Lord Kelvin's professorship is being celebrated in the most enthusiastic and magnificent manner at Glasgow. Delegates from all parts of the world are present, and among them are many of the most eminent representatives of science at home and abroad. From Paris to Moscow, Canada to Mexico, India to Australia, the whole civilised world unites in congratulating Lord Kelvin on the great work for science and the good of his fellow men which he has achieved, and in offering good wishes that he may have health and strength for the continuance of his glorious career. Though for fifty years he has been Professor of Natural Philosophy at Glasgow, has seen pass through his classes several generations of students, has been one of the greatest leaders in what has been pre-eminently a century of scientific discovery and advancement, has worked as few men can work, and withal has taken the keenest interest in all that ought to interest the true citizen of a great country, yet is his eye not dim, nor his natural force abated. It is the hope of all his friends, and of all the great army of scientific workers, who now are unanimous in doing him honour, that he may have before him many long years of happy and successful work.

Lord Kelvin, though born in Ireland in 1824, began his connection with Scotland and with the University of Glasgow at a very early age. His father, Professor James Thomson, still remembered by many alumni of Glasgow as a remarkably skilled and successful teacher, was appointed to the chair of Mathematics in 1832, so that when only eight years of age, William Thomson began his residence at the University of Glasgow. Only two or three years later he began to attend University classes, and soon attracted attention by a brilliance of intellect very remarkable in one so young. His proficiency in mathematics and natural philosophy was very great, but other studies were by no means neglected, and, under the careful supervision of his father, he received a thoroughly all-round and complete education. It may be mentioned here, that of the importance of giving its due place to science in any good scheme of liberal education, no one could be more convinced than Lord Kelvin, but that no one values more highly than he does the Old Humanities, and the importance of a sound logical and linguistic training.

While he was yet a boy, his interest was keenly excited by such subjects as the Figure of the Earth and Fourier's Theory of the Flow of Heat. On the first he wrote a University prize essay, and, on the latter, a series of papers in which he successfully defended Fourier's researches from a charge of unsoundness which had been brought against them, through some strange misconception, by a very competent writer who had graduated a few years before with the utmost mathematical distinction. It is worth relating, as indicating the promise and power of the youthful natural philosoper, that when only fourteen or fifteen years of age he read Fourier's great treatise through in the intervals of travelling about, during a fortnight's visit to Germany. That he did so to some purpose is shown by the papers in defence, explanation, and extension of Fourier's results, which soon after flowed from his pen.

There can be no question that, like many other eminent physical mathematicians, Lord Kelvin has been inspired and directed by his early study of Fourier and the other great French mathematical writers of the end of the eighteenth and the beginning of the present century. But he has always fully and gratefully acknowledged the helpful and interest-exciting influence of some of his old teachers at the University of Glasgow. To mention only one, Dr. J. P. Nichol, formerly Professor of Astronomy in the University, the compiler and, to a great extent, the author of Nichol's "Cyclopædia of Physical Science," and a most delightful lecturer on astronomical and physical subjects.

The tale of Lord Kelvin's achievements at Cambridge has been often told—how he won the first Smith's Prize and the Colquhoun Sculls, and was known as one of the most promising original mathematicians of the time. He returned to the University of Glasgow as Professor of Natural Philosophy in 1846, and from that day to this the history of his life-work has been in no small measure the history of the progress of physical science. There is no department of physical science which he has not enriched and extended by his discoveries. There is hardly any theory in dynamics, heat,

or electricity, of which his theorems, experimental discoveries and views, do not form a great and fundamental part, and in the domain of physical optics he has recently shed much light on some of the most recondite and disputed questions by his lectures and papers on the subject of the dynamics of systems, of molecules, and the constitution of the ether. To discuss his career in detail would take us too far at present, and we must refer our readers to the article in our "Scientific Worthies" series, which appeared in vol. xiv., p. 385, 1876, and defer an account of his later scientific work to another opportunity.

The accompanying engraving of the University of Glasgow shows the scene of the Jubilee Celebration. The part between the main entrance and the western gateway on the left is the physical laboratory, and the gable of Lord Kelvin's house is shown on the extreme left. A great suite of rooms, all on one level, consisting of the University Library, the Hunterian Museum, the Bute and Randolph Halls, and the Senate Room Lobbies and Examination Hall, give perfectly unique soirée accommodation, in which about 2000 guests assembled on Monday evening. In the Library has been arranged an interesting exhibit of Lord Kelvin's inventions and instruments, with the diplomas and certificates of membership which he has received from learned societies at home and abroad. There are no less than eighty or ninety of these diplomas displayed, among them some of the most illustrious distinctions, such as that of Foreign Associate of the Institute of France, to which it is possible for any scientific man to attain, a striking testimony of the universal appreciation which Lord Kelvin's work has received wherever science is cultivated or learning flourishes. The Anglo-American Cable Co., the Eastern Telegraph Co., and the Brazilian Submarine Cable Co. sent addresses of congratulation, and exhibited instruments and objects of interest as illustrating the all-important share which Lord Kelvin's discoveries, his personal services, and inventions have had in the development of ocean telegraphy. Instruments in these exhibits were during the conversazione in communication with all parts of the world, and were employed in receiving addresses of congratulation. A warm letter of congratulation was sent by the Prince of Wales, and addresses were presented by representatives of the principal universities, learned societies, and other institutions throughout the world. All the universities and almost every college in the United Kingdom and Ireland sent delegates and addresses. The addresses were publicly presented to Lord Kelvin, and Lord Kelvin himself and several of the most distinguished foreign delegates received honorary degrees at a congregation of the University specially held in the Bute Hall on Tuesday for these purposes.

A grand banquet, to which the delegates and other distinguished guests were invited by the Corporation of Glasgow, was held on Tuesday evening in the St. Andrews Hall, and at the opening of the banquet the Lord Provost read a gracious message of congratulation received from the Queen. The celebration closed by a special excursion on the Firth of Clyde, up Loch Long and round the Island of Bute, given by the University authorities.

New Buildings of the University of Glasgow. Gable of Lord Kelvin's House on extreme left. Natural Philosophical Class-room Window over Western Gateway. Physical Laboratory to right of Western Gateway.

This brief summary of the events of the celebration we hope to replace next week by a fuller account of what has been undoubtedly one of the most unanimous and enthusiastic tributes of admiration which it has ever fallen to the lot of a scientific worker to receive. That such admiration for the achievements and the personal qualities of even the most illustrious man of science has been forthcoming in no unstinted measure, is a happy augury that peace may still have its triumphs, and good work done receive its due meed of reward.

A. GRAY.

THE APPROACHING TOTAL ECLIPSE OF THE SUN.

SINCE our last note on this subject, H.M.S. *Volage*, with the instruments belonging to Mr. Norman Lockyer's party which is to observe, if possible, on the south side of the Varanger fiord, has been detached from the Training Squadron to repair a slight damage. It is expected that she will be able to leave the Portsmouth Dockyard in a few days' time, and no alterations will be made in the arrangements already published.

The accompanying map (Fig. 1) shows the possible stations south of the fiord, with the duration of totality at each.

FIG. 1.—Duration of Totality South of the Varanger Fiord.

FIG. 2.—Stars and Planets near the Sun at the Time of Totality.

It has been announced that all the ships of the Training Squadron will proceed to the neighbourhood of the Varanger fiord to observe the eclipse.

Owing to the offer of Sir George Baden-Powell to take an observing party to Novaya Zemlya in his yacht, it is quite possible that that station may be occupied by English observers as well as by the expeditions sent by the St. Petersburg Academy of Sciences and the Kasan Society of Naturalists.

An expedition from Harvard College Observatory will accompany Prof. Todd to Japan, with the special object of obtaining photographs of the progress of the eclipse with a large prismatic camera.

Mr. Crommelin has communicated to the *Journal* of the British Astronomical Association a reduced map of

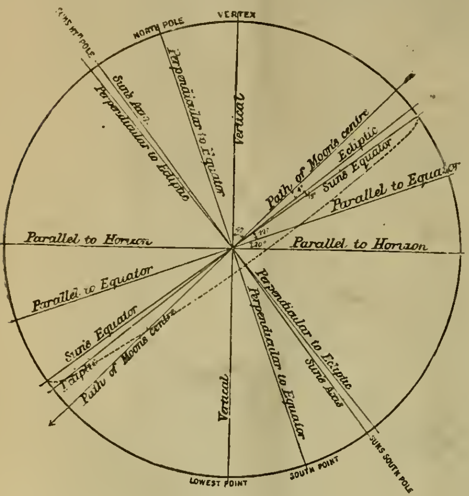


FIG. 3.—Conditions of Eclipse.

the stars and planets near the sun at the time of totality (Fig. 2), and a diagram showing the relation of the sun's axis and equator, and the path of the moon's centre to the horizon at Vadsö (Fig. 3). These, by the courtesy of Mr. Crommelin, we are enabled to reproduce.

According to Prof. Mohn, the weather chances in Lapland are vastly superior to those in Japan. We are glad also to learn that many lovers of nature are taking advantage of the opportunity of seeing one of the grandest of natural phenomena under the favourable conditions afforded by modern travel, not forgetting that the eclipse takes place in a region of beautiful scenery and in the holiday season of the year.

THE ELECTRICAL RESISTANCE OF ALLOYS.

THE recent researches of Profs. Dewar and Fleming upon the electrical resistance of metals at low temperatures have brought into strong relief the difference between the behaviour of pure metals and of alloys. In the former case the resistance shows every sign of tending to disappear altogether as the absolute zero of temperature is approached, but in the case of alloys this condition of things is widely departed from, even when the admixture consists only of a slight impurity.

Some years ago it occurred to me that the apparent resistance of an alloy might be partly made up of thermo-electric effects, and as a rough illustration I calculated the case of a conductor composed of two metals arranged in alternate laminæ perpendicular to the direction of the current. Although a good many difficulties remain untouched, I think that the calculation may perhaps suggest something to those engaged upon the subject. At any rate it affords *à priori* ground for the supposition that an important distinction may exist between the resistances of pure and alloyed metals.

The general character of the effect is easily explained. According to the discovery of Peltier, when an electric current flows from one metal to another there is development or absorption of heat at the junction. The temperature disturbance thus arising increases until the conduction of heat through the laminæ balances the Peltier effects at the junctions, and it gives rise to a thermo-electromotive force opposing the passage of the current. Inasmuch as the difference of temperature at the alternate junctions is itself proportional to the current, so is also the reverse electromotive force thereby called into play. Now a reverse electromotive force proportional to current is indistinguishable experimentally from a *resistance;* so that the combination of laminated conductors exhibits a false resistance, having (so far as is known) nothing in common with the real resistance of the metals.

If e be the thermo-electric force of the couple for one degree difference of temperature of the junctions; t, t' the actual temperatures; then the electromotive force for one couple is $e(t-t')$. If we suppose that there are n similar couples per unit of length perpendicular to the lamination, the whole reverse electromotive force per unit of length is $ne(t-t')$. Again, if C be the current corresponding to unit of cross-section, the development of heat per second at each alternate junction is per unit of area $273 \times e \times C$, the actual temperature being in the neighbourhood of zero Cent. This is measured in ergs, and is to be equated to the heat conducted per second towards the cold junctions on the two sides. If k, k' be the conductivities for heat of the two metals, l and l' the corresponding thicknesses, the heat conducted per second is

$$(t-t')\{k/l + k'/l'\};$$

or if $l/(l+l') = p$, $l'/(l+l') = q$, $l+l' = 1/n$, the conducted heat is

$$n(t-t')\{k/p + k'/q\}.$$

In this expression $p+q=1$, the symbols p and q denoting the proportional amounts by volume in which the two metals are associated. Thus when a stationary state is reached,

$$273 \times e \times C = n(t-t')\{k/p + k'/q\}.$$

This determines $(t-t')$ when C is given; and the whole back electromotive force per unit of thickness is rC, where

$$r = \frac{273 \times e^2}{k/p + k'/q}.$$

This is the expression for the false resistance per unit of thickness, which, it should specially be noted, is independent of n, the number of couples. The number of couples which co-operate is indeed increased by finer lamination, but the efficiency of each is decreased in the same proportion by the readier conduction of heat between the junctions. It is scarcely necessary to point out that the false resistance is called into play only by currents which flow *across* the laminæ.

In my original calculation the metals chosen for illustration were iron and copper. In this case (Everett's C.G.S. system of units, p. 192) $e = 1600$. The conductivities are to be measured in ergs. For iron, $k = \cdot164 \times 4\cdot2 \times 10^7$; for copper, $k' = 1\cdot11 \times 4\cdot2 \times 10^7$. Thus, if the metals are in equal volumes ($p = q = \frac{1}{2}$),

$$r = \frac{2 \times 273 \times 1600^2}{4\cdot2 \times 10^7 \times 1\cdot27} = 26\cdot2.$$

This is the thermo-electric addition to the true specific resistance, and is about $1\frac{1}{2}$ per cent. of that of copper. Such an addition may seem small; but it should be re-

membered that for the more distinctively thermo-electric metals e is much larger, and that it enters by its square. In any case it seems desirable that this complication should be borne in mind. The consequences which follow from recognised laws for laminated structures, however fine, must surely have some bearing upon the properties of alloys, although in this case the fineness is molecular.

RAYLEIGH.

NOTES.

THE De Morgan Memorial Medal has been awarded this year by the Council of the London Mathematical Society to Mr. Samuel Roberts, F.R.S. The medal is awarded every three years. Mr. Roberts was one of the earliest members of the Mathematical Society, and his first mathematical papers were contributed to the Society over fifty years ago. Since then he has continued, in the intervals of a busy professional career, to interest himself in the study of higher mathematics, and has published numerous papers, many of them of great value. The presentation of the medal will be made at the annual meeting of the Society in November next.

THE Council of the Society of Arts are prepared to award, under the terms of the Benjamin Shaw Trust, a gold medal, or a prize of £20. The medal, under the conditions laid down by the testator, is to be given "for any discovery, invention, or newly-devised method for obviating or materially diminishing any risk to life, limb, or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means." Intending competitors should send in descriptions of their inventions not later than December 31, 1896, to the Secretary of the Society of Arts, Adelphi, London, W.C.

ON Thursday last, a preliminary meeting was held in the Board Room of the Museums, William Brown Street, Liverpool, for the purpose of taking steps for the establishment in that city of a Zoological Garden on a scientific basis, and on the model of that in Regent's Park, London. On the motion of Prof. Herdman, seconded by Dr. Forbes, the following resolution was unanimously adopted:—"That in the opinion of this meeting it is desirable, in the interests of science and education in this city, to establish Zoological Gardens, containing a collection of living animals, and that those present form a Committee, with power to add to their number, for the purpose of advancing this object." The question of a site was considered, and it appeared that there was just now a favourable opportunity of securing land in a central position very suitable for the purpose. It was resolved that the following gentlemen be asked to form a sub-Committee to inquire fully into the matter, and prepare a report:—Prof. Herdman, Dr. Forbes, Messrs. A. L. Jones, A. A. Paton, A. S. Hannay, W. H. Picton, W. E. Willink, F. J. Leslie, and F. Radcliffe.

PRESIDENT CLEVELAND has appointed a scientific commission to investigate the condition of the fur seals in the North Pacific and Behring Sea. The members of the Commission are Mr. Jordan, of Stamford University (President), Lieutenant-Commander Moser, commanding the Fish Commission steamer *Albatross*, Dr. Stejneger and Mr. Lucas, both of the U.S. National Museum, and Mr. Townsend, Fish Commissioner.

THE recent electrical exposition in New York City proved so successful, pecuniarily as well as otherwise, that the managers have decided to establish a permanent exhibition. A revised estimate of the distances covered by the long-distance telegraphing at the exhibition on May 16, is 42,000 miles for the message to Tōkiō and back, covered in 47½ minutes, and over 15,000 miles for the double crossing of the North American continent and the Atlantic ocean, covered in four minutes.

THE Division of Forestry of the United States Department of Agriculture calculates the annual loss by fire to the forests in the States to amount to twenty-five million dollars.

AMONG the subjects of prizes for essays offered by the Royal Academy of Sciences of Denmark are:—Morphological and physiological researches on the asci of the Ascomycetes; the Danish species of Nematoids and Anguillulinæ; and the life-history of those Sphæriaceæ which are destructive to cereal crops.

IN the *Berichte* of the German Botanical Society, Herr A. Schober gives the result of some experiments on the effect of the Röntgen rays on the germination of the oat. He concludes that they differ from ordinary light rays in having no power of producing heliotropic curvatures, even in organs so sensitive to light as the axis of a growing seedling.

DR. Q. MAJORANA and Dr. A. Sella continue their researches on the effect of Röntgen rays and ultra-violet light on the discharge of electric sparks in air. In their latest communication to the Reale Accademia dei Lincei, they consider the manner in which the nature of the discharge is affected both by the action of these rays and by varying the sparking distance. Their present contribution includes a figure and description of the apparatus illustrated in their recent letter to NATURE, as well as of another arrangement by which the phenomena are well shown.

THE July number of the *Leisure Hour* is to contain a series of portraits of the Presidents of the Royal Society from its foundation, in 1662, to the present day. The portraits, thirty-four in number, occupy six pages of royal octavo, and form, so far as we know, an unique series. Of the thirty-six Presidents, two only—James West and Sir Cyril Wyche, neither of them very eminent men from a scientific point of view—are wanting. The accompanying article, on the Presidents of the Royal Society, has been been written by Mr. Herbert Rix, late Assistant Secretary to the Society.

THE earth-tremors and sounds produced by the Niagara Falls have been often referred to, in most cases probably with some exaggeration as regards their intensity. In a paper published in the *Yale Scientific Monthly* for last May, Mr. W. H. Brewer describes some careful observations made at various times during the last forty-five years. During one year spent at Lancaster, a village twenty-seven miles from the Falls, sounds, possibly due to the Falls, were heard on three occasions, but it was uncertain whether they might not have come from Buffalo, which is hardly ten miles distant. The tremor observations were made within a few miles of the Falls, and show that the vibrations are extremely irregular, varying both in amplitude and period. Sometimes they stop for an instant, then steadily increase in intensity, reaching one or several maxima, afterwards steadily declining. The momentary pauses do not, however, recur at regular intervals.

THE *Board of Trade Journal* reports that the Pharmaceutical Society of Prague will celebrate its twenty-fifth anniversary this year by an international exhibition of pharmacy, to be held from August 15 to September 15, at Prague, and to include the following groups:—Scientific apparatus and articles used in pharmaceutical work, and the literature having reference to same; machinery and various apparatus serving for the manufacture of pharmaceutical articles, pharmacy fittings, &c.; products and drugs used in pharmacy; manuscript books, statistics, and tables concerning the historical development of pharmacy; hygiene, and the care of invalids. There has been

no important exhibition of pharmacy in Europe since 1883, and the forthcoming one at Prague this year is to include all features of progress in the pharmaceutical branch and its ramifications. Meetings of various pharmaceutical societies will be held at Prague during the exhibition. Particulars may be obtained from Dr. Charles Fragner, Pharmacien, Président du Comité Exécutif, à Prague.

IN connection with the cloud observations to be made during the international cloud year commencing May 1, *Science* of May 29 has some interesting notes by Mr. R. De C. Ward, of the Harvard University, on scientific kite-flying under the superintendence of the Washington Weather Bureau, and the Blue Hill Observatory. Instead of being flat and tapering at the lower end, the kites used are box-shaped, with their ends open and their sides partly covered with cloth or silk, and when fine piano wire is used, instead of twine, they are found to be splendid flyers. Recent ascents have reached altitudes of nearly a mile above sea-level, and excellent results have been obtained by means of a self-recording instrument made by Mr. Fergusson, of the Blue Hill Observatory, which gives automatic readings of temperature, pressure, humidity, and wind velocity. Among the most important matters that have hitherto been noted is the presence of cold waves and warm waves at considerable elevations some hours before the temperature changes are noted at the earth's surface. The prospect of improving weather forecasts by such means and by the use of small pilot balloons, which can be made at slight expense, and can reach considerable altitudes, is considered to be very encouraging.

IN a paper in the *Photographische Mitteilungen*, Jahrgang 33, Hefte 1 and 2, entitled "Über chromatische Homofocallinsen und über meine chromatische Planparallelplatte," Dr. Hugo Schroeder gives an account of the uses that may be made of a compound lens of which the external surfaces are plane and parallel, while the component lenses join internally at surfaces of any convenient curvature. The simplest form of a double lens of this kind may be derived from an ordinary plano-convex achromatic objective by grinding the front (convex) surface of the crown lens to a plane. Such a lens would evidently have almost exactly the same chromatic and spherical aberrations as the removed plano-convex portion, but with the opposite signs. By substituting crown glass for flint, and *vice versa*, the character of the lens may be reversed. Inserted in the cone of rays coming from an achromatic object-glass, a suitable plane lens of this kind shows what would be the effect of altering the curvatures of the surfaces of the object-glass. For this kind of lens Dr. Schroeder proposes the name of "Corrector." Again, by the use of such a corrector an ordinary achromatic telescope may be fitted for photographic work, and this can be done without greatly changing the place of the focal plane. By moving the corrector along the axis, different groups of rays may be brought together to suit the photographic method employed. As independently pointed out by Prof. Keeler and Mr. Newall, one difficulty, however, cannot be overcome: the available field of view will always be very restricted; unless, indeed, the correcting lens is made so large as to become practically an extra member of the object-glass.

FROM an artesian well, 188 feet deep, recently bored at San Marcos, Texas, there were expelled more than a dozen specimens of a remarkable batrachian, together with numerous crustaceans. The latter are described by Mr. Benedict, and the batrachian by Dr. Stejneger (*Proc. U. S. Natl. Mus.*, vol. xvii., 1896). From the *American Naturalist*, it appears that the crustaceans comprise numerous shrimps (one new species, *Palæmonetes antrorum*), a lesser number of Isopods of a new genus (Cirolanides), and a very few Amphipods. All the species are white, blind, and have unusually long, slender feet and antennæ. The batrachian, for which Stejneger creates a new genus, is described under the name *Typhlomolge rathbuni*. It belongs to the family Proteidæ, and is more nearly allied to Necturus than to Proteus. Like the crustaceans, it is blind. The most remarkable external feature is the length and slenderness of the legs. In commenting on this peculiarity, Dr. Stejneger says: "Viewed in connection with the well-developed finned swimming tail, it can be safely assumed that these extraordinarily slender and elongated legs are not used for locomotion, and the conviction is irresistible that in the inky darkness of the subterranean waters they serve as feelers, their development being thus parallel to the excessive elongation of the antennæ of the crustaceans." The gills are external, its colour nearly white, having the upper surfaces densely sprinkled with minute pale grey dots, and its total length measures 102 mm.

YET another method or the separate identification of the colon from the typhoid bacillus has been furnished to the bewildered bacteriologist by Dr. Piorkowski from Berlin. Recognising the fact, now established by so many investigators, that both the colon and typhoid bacillus are frequently found in urine, and that the former is regarded as undoubtedly intimately associated with various processes of inflammation, Dr. Piorkowski has compared the growth of these two micro-organisms in broth, gelatine, and agar, to which he made additions of urine. He states that whereas the typhoid-bacillus cultures, both in colonies and tubes, exhibited fine hairy extensions resembling in the case of the colonies the well-known medusa-head-like appearance so characteristic of the anthrax bacillus, the colon bacillus never forsook its compact form of growth, and only occasionally were very small, short hairy extensions visible in the contour of the colonies. We agree with Dr. Piorkowski that his method of diagnosis is easily applied, but we are not altogether convinced as to its efficacy. Colonies of the colon bacillus may also exhibit very characteristic whip-like extensions under circumstances which at present we are not in a position to exactly determine, but these so-called abnormal colonies were obtained from colon bacilli derived from a sample of cystitis-urine. Already the catalogue of comparative tests is considerable through which typhoid and colon bacilli are required to be passed, and unless a decided advance can be recorded on these, we think it is unnecessary that the bacteriologist should add to his burdens by adopting any more.

THE artesian water question continues to largely occupy the attention of Australian geologists and engineers. We have received an abstract of Mr. J. P. Thomson's presidential address to the Royal Geographical Society of Australasia, on the alleged leakage of artesian water. The address seems to have been called for by the too ready acceptance by local writers of Mr. R. L. Jack's tentative suggestion that the artesian water of the porous Lower Cretaceous beds might largely leak away to the sea. Mr. Thomson considers there is no evidence of such leakage: it is true that at various places off the coast fresh water is known to rise through the sea-water from below, but there is no evidence to associate such submarine springs with Lower Cretaceous outcrops—the water may more probably be derived from the Tertiary beds which form the actual coast. On the other hand, the geological structure of the continent seems to prevent the possibility of an unbroken flow of water to a submarine outcrop, if such outcrop exists. Referring to the asserted great excess of the rainfall over the river-flow, which had been put forward as evidence of the artesian leakage, he points out on the one hand the enormous evaporation in such a climate as that of Central Australia (quoting some striking instances of this), and on the other hand, that there has hitherto been no systematic gauging of the flow of the Australian rivers.

PROF. J. S. BASSETT, in his "Slavery and Servitude in the Colony of North Carolina" (*Johns Hopkins Univ. Studies in Hist. and Polit. Sci. Studies*, 14th ser., iv.-v.), has recently published a valuable study on the history and sociology of slavery in North Carolina. In the West Indies the Spaniards early destroyed the native population, and so they imported the negro, and established colonies of slaves, driving them to the fields and back to the barracks, and treating them much as the Romans did their slaves. The ideal of the Virginian planter was that of an English county gentleman: he wanted to group his slaves around him, and deal personally with them. There were, however, two main obstacles: (1) the Indians must be either exterminated or driven into the interior, for fear of massacres; (2) the white population must become dense enough to resist any insurrection among the negroes, hence large numbers were not introduced at first. About 1712, these obstacles were practically removed. The first slaves in America were Indians; but as they were fierce and caused trouble, they were never very numerous. The first labourers the English took to the New World colonies were whites; these consisted of indented servants, transported felons, and kidnapped persons, usually children. From 1661-1671 the conscience of the English public was awakened, so that only properly registered emigrant servants could be taken across the Atlantic; besides, negro slaves were found to be cheaper than white servants. It was the survival of the fittest. Both Indian slavery and white servitude were to go down before the black man's superior endurance, docility, and labour capacity.

DR. BASSETT'S account of the social conditions of the natives is also interesting; nor is the history of the attitude of religion to the slave question less so. At first, at all events, the planters were unwilling to allow the conversion of negroes, there being a doubt in their minds whether conversion would not enfranchise them. When the negroes happened to be professed Christians they might join any church they liked, but till 1741 they were not allowed to have a church organisation or building among themselves. With the exception of the Society of Friends, who became unanimous on this point in 1776, none of the sects opposed the ownership of slaves.

A TRANSLATION of Dr. Carl Freiherr v. Tubeuf's "Diseases of Plants due to Cryptogamic Parasites," by Dr. W. G. Smith, is about to be published by Messrs. Longmans.

DR. J. DOERFLER, of Vienna, has published his *Botaniker Adressbuch*, a guide to botanists throughout the world. It contains upwards of 6000 addresses of botanists, as well as those of botanical gardens, botanical institutes, societies, and journals.

WE have received vol. iii., No. 4, of the "Bulletin from the Laboratories of Natural History of the State University of Iowa," containing several papers on the fauna and flora of Iowa, as well as of Mexico, Arizona, and Nicaragua. The *Botanical Gazette* has long been urging American naturalists to compile their local faunæ and floræ on some more satisfactory lines than the often very arbitrary division-lines between the States.

M. J. DAVEAU describes, in the *Journal de Botanique*, a remarkable example of proterandry extending over a whole season, in the case of a palm (species not given) belonging to the genus *Kentia* (*Howea*) grown in the open air in the Botanic Garden at Lisbon. The flowers are grouped together in clusters within the spathe, each cluster consisting of three flowers, two male and one female. The female flower in each cluster is only in a very rudimentary condition, even after the male flowers have shed their pollen and dropped; they remain in this condition through the autumn and winter, and expand only at the same period in the next summer, when the male flowers in other newly-formed inflorescences are discharging their pollen.

SCIENTIFIC book-hunters will be glad to have their attention called to two lists just issued. One comes from Messrs. Macmillan and Bowes, Cambridge, and contains the titles of more than seventeen hundred books and papers on pure and applied mathematics, astronomy, meteorology, chemistry, and other branches of physical science, from the libraries of the late Prof. Henry Smith and Mr. Cowper Ranyard; the other contains the titles of 341 works on branches of natural science, offered for sale by Messrs. Williams and Norgate.

MESSRS. J. B. LIPPINCOTT CO. have published a second edition of "A Manual of North American Birds" by Mr. Robert Ridgway. The work now runs into 653 pages, and is illustrated by 464 outline drawings of the generic characters. The knowledge of North American birds gained since the publication of the work in 1887, has been fully utilised in the preparation of the new edition; and the new species and sub-species added since that date are given in an appendix. Ornithologists, and particularly those in the United States, will be glad to have this carefully revised edition of a valuable manual.

OBSERVATIONS of local meteorology carried on in a systematic way, as they are in the Observatory of the Southport Town Council, furnish data of more than local value. The report of Mr. Joseph Baxendell, Meteorologist to the Corporation, upon the results of observations made in 1895 at places within and around the borough of Southport, has just been received, and it testifies to a large amount of careful work. In the course of his introductory remarks, Mr. Baxendell refers to "the serious differences between the indications of the Campbell-Stokes Standard and the Jordan Photographic Sunshine Recorders." It is hardly satisfactory that the duration of sunshine should be recorded so differently by the two classes of instruments.

THE Royal Cornwall Polytechnic Society has published its sixty-third annual report, being for the year 1895. For many years the Falmouth Observatory, in connection with that Society, has been one of the principal stations of the Meteorological Council, and in addition to the records of the photographic and other self-recording instruments required by that body, it publishes results of magnetic and sea temperature observations. During the year in question, Prof. Rücker spent some time at the observatory for the purpose of comparing the magnetic instruments with those at Kew, and his report bears testimony to the skill and accuracy of the observer, and to the thoroughness of the work done. The Society holds an annual exhibition, when any special features are introduced by which industry may be encouraged, and visitors interested and instructed. The report contains accounts of interesting lectures on the old Falmouth Packet Service, by Mr A. H. Norway, and on some senses in fishes, by Mr. M. Dunn

UNDER the title "Lloyd's Natural History," Messrs. Edward Lloyd (Limited) is issuing in parts the works which Messrs. W. H. Allen and Co. have for the past two or three years been publishing as "Allen's Naturalist's Library," and which is itself a revised and enlarged edition of "Jardine's Naturalist's Library." The first part of this *réchauffé* series has just been received, and we may be pardoned a little surprise at finding that no reference is made in it to the original edition, so that to the general public "Lloyd's Natural History" appears as a new work. The present part comprises 112 pages and eleven coloured plates, and is a section of one of the volumes on "British Birds" contributed by Dr. Bowdler Sharpe to "Allen's Naturalist's Library." We are glad to see the issue of this series in parts, notwithstanding the information withheld as to the origin of it. In spite of the many unsatisfactory figures, the work is sound and methodical, and its serial publication wil undoubtedly increase the number of students of natural history.

SEVERAL parts of the very fine "Illustrations of the Zoology of H.M. Indian Marine Surveying Steamer *Investigator*," under the Commander, A. Carpenter, the late Commander, R. F. Hoskyn, and Commander C. F. Oldham, have lately been received. The plates are splendid examples of photo-etchings, and they will be treasured by marine zoologists. Fishes are represented upon sixteen plates, Crustacea upon fifteen plates, and Echinoderma upon five plates. The illustrations are only accompanied by brief explanations, the descriptions of the various species having appeared in the *Annals and Magazine of Natural History*, and in the *Journal of the Asiatic Society of Bengal*. Mr. A. Alcock is responsible for the fishes described and figured, and, in conjunction with Mr. A. R. S. Anderson, for the Echinoderma. The Crustacea have been mostly done under the direction of the late Mr. J. Wood-Mason.

NEARLY a year ago (NATURE, vol. lii. p. 290), the second volume of the second edition of Dr. George Lunge's treatise on "The Manufacture of Sulphuric Acid and Alkali" (Gurney and Jackson) was reviewed in these columns, and the value of the work to investigators and industrial chemists as a standard work of reference on alkali manufacture was pointed out. The third volume, completing the second edition of the book, has now been published, and the words of praise applied to the second volume are just as fully deserved by the present one. The amplification of the original text has been so considerable, and the revision so thorough, that the work has grown beyond recognition. Only a few chapters resemble those of the first edition, and the chapters on ammonia-soda, on the more recent soda-process, on the Deacon process, and the other chlorine processes, have been entirely rewritten; while a section on the preparation of alkalis, chlorine, and chlorates by electrolysis, appears for the first time. The second edition of the complete work is half as large again as the first; it is well up to date, and forms a most serviceable survey and digest of the whole ground of alkali manufacture.

THE meteorological and magnetic observatory of the University of Odessa has for its functions not only the reading of the numerous instruments with which it is equipped, and the discussion of the results observed and registered, but it is intended also to serve as a high school where students of the faculty of physics and mathematics can be trained in the work of meteorology and physical geography. In order to give more importance to this course, Prof. Klossovsky has drawn up a syllabus, which is printed in the 1895 volume of the "Annales" of the Observatory at Odessa. The course is divided into three parts, the first two of which are devoted to fundamental observations, to the installation and study of instruments used in meteorology and terrestrial physics, and to the determination of various elements. The third course is intended for those who propose to take up physical geography or meteorology as a special subject. The programme is an admirable outline of the work of meteorology and terrestrial physics, and but for limit of space we would give a full translation of it. Schools in meteorology are so few, that the development of the curriculum of the Imperial University at Odessa will be welcomed by all who think that trained investigators and experimental work are needed for the advancement of the science.

THE additions to the Zoological Society's Gardens during the past week include a Hoolock Gibbon (*Hylobates hoolock*, ♀) from Assam, presented by Mrs. Firman; two Fat Dormice (*Myoxus glis*) from Austria, presented by Mr. John G. Haggard; a Short-toed Eagle (*Circætus gallicus*) from Egypt, presented by Dixon Bey; a Vulturine Eagle (*Aquila verreauxi*) from South Africa, presented by Mr. J. Clark; two Short-eared Owls (*Asio brachyotus*) from Ireland, presented by Captain R. A. Ogilby; five Cormorants (*Phalacrocorax carbo*) from the Isle of Mull, presented by Maclaine of Lochbuie; three Dwarf Chameleons (*Chamæleon pumilus*) from South Africa, presented by Miss Jessie M. Hudson; eight Natterjack Toads (*Bufo calamita*), two Common Toads (*Bufo vulgaris*), British, presented by Mr. Stanley S. Flower; two Axolotls (*Siredon mexicanus*) from Mexico, presented by Mr. W. Temple; nine Green Turtles (*Chelone viridis*) from Ascension, presented by Mr. J. C. Adlam; a Hoolock Gibbon (*Hylobates hoolock*, ♀) from Assam, an Indian Chevrotain (*Tragulus meminna*), two Indian Drongos (*Chibia hottentota*), two Tigers (*Felis tigris*, ♂ ♀) from India, a Javan Chevrotain (*Tragulus javanica*) from Java, a Harnessed Antelope (*Tragelaphus scriptus*, ♂) from West Africa, deposited.

OUR ASTRONOMICAL COLUMN.

PHOTOGRAPHS OF STELLAR SPECTRA.—Dr. F. McClean is now engaged on a photographic investigation of the spectra of the northern stars down to the third magnitude. About 160 stars will thus be included in the survey. Some of the results, which have been recently communicated to the Royal Astronomical Society, comprise the spectra of twenty-three characteristic helium stars, and photographs of the spectra of six stars of the third magnitude showing the transitions from one type to another (*Monthly Notices*, vol. lvi. p. 428). The instrument used is a photographic telescope of 12 inches aperture and 11 feet 3 inches focal length, having an objective prism of the same aperture placed in front of the object-glass. The refracting angle of the prism is 20°. The prism is mounted on a hinged frame, and the cell containing it can be rotated within the frame, so that all necessary adjustments can be effected with facility.

THE NATAL OBSERVATORY.—Two reports which have recently been received from Mr. Nevill, the Superintendent of the Natal Observatory, indicate considerable astronomical activity at this southern station. "The principal series of observations in progress is the comparison of the declination deduced from observations made at the observatories in the northern and southern hemispheres by a comparison by Talcott's method of the zenith distance of northern zenith stars and southern circumpolar stars at upper and lower culminations." Over a hundred pairs of stars are under observation. The publication of the Greenwich observations of Mars during the opposition of 1892 renders it possible to utilise the corresponding Natal observations for the determination of a new value of the solar parallax, and this work will be undertaken. During the opposition of Mars in 1894 the weather proved very unfavourable, and no observations of value were secured. A great mass of important work done at the observatory awaits facilities for publication. The entire staff amounts to only four observers and computers, and the instrumental equipment is equally small. The system of time signals and meteorological work were carried on as in former years.

POSSIBLE CHANGES IN THE EARTH'S ROTATION.—As the result of a recent investigation (*Comptes rendus*, June 1), Prof. Newcomb makes the startling suggestion that the earth's rotation is not perfectly uniform. The discussion was undertaken in connection with the long-period inequalities in the moon's mean motion, which so far have not been satisfactorily explained. The possibility of a variation in the earth's rotation period being admitted, and consequently of an error in our mode of reckoning time, it becomes necessary to employ some method of measuring time which shall be independent of the earth's rotation. This appears to be best furnished by observations of the transit of Mercury. Prof. Newcomb has accordingly discussed all the November transits since 1677, and has compared the observed times of ingress and egress with those computed on the basis of his new tables for the sun and Mercury. Although in many cases the residuals may not be greater than the probable errors, there is a significant systematic character about them, as shown when the observations are grouped as follows:—

Transits.	Residuals. s. s.
1677—1769	-5.4 ± 2.5
1789—1861	$+6.4 \pm 1.5$
1868	-1.5 ± 3.5
1881—1894	-3.1 ± 1.6

It is concluded that "the observations of transits of Mercury clearly indicate small variations in the rotation of the earth, of

which the integral amount, during long periods of time, probably reaches five, or even ten seconds. In particular it seems that between 1769 and 1789 a retardation of the earth's rotation took place, and another between 1840 and 1861. Towards 1862 this slackening was followed suddenly by a well-marked acceleration, which possible persisted up to 1870."

It may be added that the supposed variation does not seem to account for the lunar inequalities to which reference has been made.

THE LADIES' CONVERSAZIONE OF THE ROYAL SOCIETY.

THE second of the two annual conversaziones of the Royal Society—the one to which both ladies and gentlemen are invited—was held in the rooms of the Society at Burlington House, on the evening of Wednesday in last week. As many of the scientific novelties exhibited were shown at the conversazione held in May, and have already been described in these columns (May 14), it is unnecessary to refer to them again. Only the new exhibits are therefore described in the present report.

In addition to Mr. Herbert Jackson's demonstration of the various degrees of phosphorescence of different subjects under the action of Röntgen rays, several other exhibits were devoted to methods used and results obtained with the rays. Prof. S. P. Thompson showed the production of electric dust-shadows by Röntgen rays. When the rays are allowed to fall upon an electrified sheet of aluminium placed above a plate of ebonite, they carry electric charges to the plate and electrify it. If objects of metal are laid on the ebonite sheet they intercept the Röntgen rays, and the part of the ebonite surface immediately shaded by them does not become electrified. On removing the ebonite plate and dusting upon it Lichtenberg's powders (mixed sulphur and red lead), the electric shadows become visible.

Prof. Thompson also showed a number of experiments on Röntgen's rays, viz.: (*a*) Cryptoscopic use of luminescent screens (revealing contents of packages, bones of hand, &c.) by employment of focus tube (Jackson's pattern); (*b*) discharge of electroscope by Röntgen rays; (*c*) new forms of X-ray tubes, including one for insertion in mouth; (*d*) apparatus of Ebert for producing luminescence by electric oscillations; (*e*) stereoscopic Röntgen-ray photograph of rabbit.

Electric discharges in vacuum was the subject of exhibits by Messrs. Siemens, Bros., and Co. The exhibits were (1) a facsimile of Dr. Wm. Watson's vacuum tube of 1751. This was the first apparatus ever constructed for experiments on the electric discharge in a vacuum. The discharge from a Leyden jar passed through ten inches, and that from a frictional machine through three feet, the whole length of the tube. (2) Facsimile of Lord Cavendish's double barometer of 1751, used by Dr. Wm. Watson in his researches. (3) Facsimile of Dr. Wm. Morgan's shortened barometer of 1785. Dr. Morgan, by long-continued boiling of the mercury in a barometer tube, produced a vacuum of such excellence that no discharge would pass, and equal, therefore, to that in a Hittorf or Crookes' tube of the present day. It is probable that it would have sufficed for the production of Röntgen rays. (4) Apparatus for showing electric discharges at different degrees of exhaustion from 70 mm. to 0 mm. (5) Photographs obtained by means of Röntgen rays, showing relative transparency of different kinds of wood, minerals, and glass.

A series of striking Röntgen photographs was shown by Dr. Macintyre. The marvellous advance made in Röntgen photography will be understood from the following statement of the subjects of Dr. Macintyre's pictures: (1) *Hard Structures.*—Life-sized photographs of different parts of the human skeleton, including the spine, ribs, shoulder, elbow and other joints of the body. Some of the negatives were 24 by 20 inches. (2) *Animal Kingdom.*—A series of the animal kingdom, such as the fish, frog, adder, &c. (3) *Soft Tissues of the Body in Health and Disease.*—Human heart in the living adult subject. The same in health and disease, also the tongue, tissues of the neck, including the larynx, &c. (4) *Instantaneous Photographs of Different Objects.*—The time of exposure was unknown, but the most rapid picture shown was taken with a single flash of the tube, due to one vibration of the interrupter of a ten-inch spark coil.

Mr. J. J. H. Teall exhibited a series of photographs of the electric discharge at various stages during the exhaustion of a Crookes' bulb of the Jackson type.

A small dynamo for measuring the permeability and hysteresis of iron was exhibited by Prof. W. E. Ayrton and Mr. T. Mather. The specimen to be tested, which may be in the form of a round bar or a bundle of thin plates, forms the yoke of the dynamo, and through a coil surrounding it is passed the magnetising current, the winding of this coil being so arranged that the current in amperes is numerically equal either to the magneto-motive force per centimetre of the bar, or to one-tenth of that value. When the armature is run at a speed of 1150 revolutions per minute, the induction per square centimetre in the bar is approximately equal to 10,000 times the E.M.F. in volts produced. Hence not merely the magnetising current but also the induction is measured by a *steady* deflection, and not, as is usual, by the *instantaneous* swing of a ballistic galvanometer. The magneto-motive force required for the air-gap and joints is determined experimentally by the use of a standard bar whose B H curve is accurately known.

Mr. J. Frith demonstrated the different effects produced by superimposing a small alternating current on a direct current arc according as cored carbons or solid carbons are employed. When a small alternating current is superimposed on a direct current arc formed with *cored* carbons, the oscillations of potential difference and current are in the *same* direction for all frequencies higher than about $1\frac{1}{2}$ periods per second. On the contrary, if the carbon be *solid*, the oscillations of potential difference and current are in the *opposite* direction for all frequencies tried up to 256 periods per second. This difference was exhibited by the visible motion of ammeter and voltmeter needles.

Microscopic internal flaws inducing fracture in steel axles, rails, and propeller shafts were shown by Mr. T. Andrews. This exhibit consisted of a series of accurate micrographs taken at a high magnifying power, illustrative of the microscopically visible and tangible micro-flaws, almost invariably present in considerable number, in steel railway axles, rails, tires, propeller shafts, &c. The presence of these germs of metallic disease in steel (mostly due to sulphur and other impurities) greatly influences the deterioration by fatigue of the metal, and they are a potent factor in inducing the sudden fracture of engineering constructions in steel.

Mr. J. Macfarlane Gray exhibited a multiplication frame. In this contrivance, for obtaining the product of two multidigital numbers, product cards, as on "Napier's rods," are set for one of them upon a sole frame, and sliders on a grid are shifted to set up the other. Each slider has a pane of plass at mid-length. The grid is fitted to the sole frame upon a pair of stepped guides, and is slid along over the cards one figure at a time. At each step the component products in one of the vertical columns of the common multiplication rule are exhibited at the panes and added mentally. In this way the final product is obtained without transcribing the intermediate products.

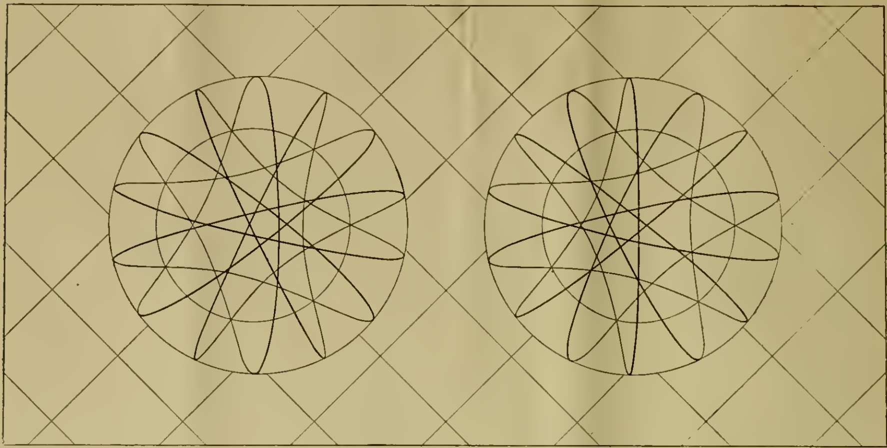
Exhibits illustrative of applications of the mathematical theory of frequency were shown by the Applied Mathematics Department of the University College, London. They included: (1) Diagram illustrating the relative variation of different organs in men and women of diverse races, by Miss Alice Lee, G. U. Yule, and K. Pearson. (2) Diagrams showing that 25 per cent. of the married population produce 50 per cent. of the next generation—Reproductive Selection, by K. Pearson. (3) Diagrams illustrating barometric frequency over the British Isles, by Miss Alice Lee, C. Jakeman, and K. Pearson. (4) Frequency recording barometer, by G. U. Yule and Cambridge Instrument Co. (5) Amplified integrator for finding mean, mean square and mean cubic deviations, and frequency skewness, by Amsler-Laffon. (6) Prof. Ranke's craniophor, used in comparing variation of skulls, as determined by English and German methods, by A. Martin-Leake and K. Pearson. (7) Skew binomial machine, by G. U. Yule. (8) Model of contour-tracer for finding areas of section of small objects.

Stereoscopic views of algebraic spherical catenaries and gyrostat curves were exhibited by Prof. A. G. Greenhill and Mr. T. I. Dewar. The mathematics of the spherical catenary are discussed in a paper by Prof. Greenhill in the volume of the *Proceedings of the London Mathematical Society* for the current year, and a diagram of a closed algebraical one with five

loops is there given. This was the first case in which it had been found possible to express the integral

$$\int \frac{Adz}{(1 - z^2)\sqrt{Z}}$$

algebraically, where $Z = (1 - z^2)(h - z)^2 - A^2$, and A and h are constants. The accompanying diagram is for the next possible case of seven loops, and has been made by Mr. T. I. Dewar. The circle in the lower hemisphere shows where the pressure of the chain on the sphere becomes zero; below that, the chain is supposed to rest on the interior of the hollow sphere. The tesselated pavement indicates the position of the *directrix-plane*. The tension at any point of the catenary is the same as in a chain hanging vertically to this plane, like a similar property in the plane catenary. A great many other cases with different numbers of loops have been examined, but the results turn out to be imaginary



Mr. Robert L. Mond exhibited the following apparatus intended for the Davy-Faraday Research Laboratory of the Royal Institution: (1) Kilogram automatic balance (Rueprecht, Vienna). (2) Prism automatic spectroscope (Kruss, Hamburg). (3) 1-inch spectrometer after Landolt and Brühl (Hildebrandt, Freiberg). (4) Hüfner photo-spectrometer (Albrecht, Tübingen). (5) Large polariscope 6-inch Landolt. (6) Small Landolt polariscope (Schmidt and Haensch). (7) Berthelot platinum bomb (Golaz, Paris). (8) Glass scale cathetometer (R. Fuess, Berlin). (9) Petrographical microscope (R. Fuess, Berlin). (10) Millivolt meter reading Centigrade degrees for Le Chatelier Thermophile (Keiser and Schmidt, Berlin). (11) Compensation box of Physikalische Reichsanstalt, Berlin (Wolff, Berlin). (12) Set of standard resistances (Wolff).

Prof. Dewar showed a portable apparatus for the production of liquid air and oxygen. A working model of support for large specula, designed to leave the line of collimation undisturbed, was exhibited by Dr G. Johnstone Stoney.

Mr. F. McClean exhibited (1) photographic stellar spectra of Type III., including spectra of *o* Cetus (showing bright lines Hγ and Hδ), α Taurus, α Orion, α Scorpio, β Andromeda, α Cetus, δ Ophiuchus, μ Gemini, δ Virgo, β Pegasus, α Hercules. (2) Photographic spectrum of Secchi's Type IV. This was a spectrum of the star 152 Schjellerup ($5\frac{1}{2}$ magnitude), compared with spectrum of α Orion. (3) Series of photographic spectra of the variable star β Lyra, compared with spectra of β Orion and δ Taurus.

A new form of stereoscope was shown by Sir David L. Salomons. This stereoscope has been designed to suit the vision of all persons, without straining the eyes. Many individuals who are unable to use the ordinary stereoscope have been able to obtain the solid effects with this instrument. The lenses may be angled, and moved to and from the centre at will. Also the distance can be varied between the picture and the lenses. The distance between picture and lenses is greater than usual, to allow a wider mirror, which is advantageous.

A number of cloud photographs taken in different parts of the ocean world were exhibited by Captain D. Wilson-Barker; and Mr. F. H. Worsley-Benison exhibited a series of seascape photographs. The photographs were enlargements in carbon. The whole picture in each subject was the result of one exposure only.

Coming now to natural science: Models of the flowers of *Aristolochia gigas* from Brazil, and of *Stapelia gigantea* from Natal (made by Miss Emett for the Museums of the Royal Gardens, Kew) were exhibited by the Director, Royal Gardens, Kew. Flowers with livid colouring and exhaling indol or some allied body occur in different families of the vegetable kingdom. Kerner ("Natural History of Plants," translated by F. Oliver, vol. ii. pp. 197–200) thus describes them: "Flowers provided with indoloid scents resemble animal corpses in their colouring, having usually livid spots, violet streaks and red-brown veins on a greenish or fawn-coloured background." "Such flowers . . . are always visited by carrion-flies or dung-bettles in abundance."

The Director of the Royal Gardens also showed photographs of Hæmatozoa of fly disease of South Africa (exhibited on behalf of the Government of Natal). For the last half-century the Tsetse-fly has been notorious as a terrible scourge to live-stock, and the most formidable of impediments to colonisation in Equatorial and South Africa. Surgeon-Major Bruce has now discovered that the fly is itself innocuous, and is only fatal to animals when it is the carrier of a flagellated infusorian (*hæmatozoon*) which it introduces into their blood.

Two coloured casts of the New Zealand lizard, Hatteria or Sphenodon, were exhibited by Prof. Ray Lankester. The casts were taken at the Zoological Society's Gardens from a full-grown specimen immediately after death, and painted by Prof. Lankester, so as to give the natural colours. Stuffed specimens of lizards' skins are very difficult to prepare with any approach to natural form and folding of the skin. Such casts as those shown are useful as preserving form and pose.

Mr. Frederick James exhibited examples of British Lepidoptera (*Rhopalocera*) denuded of scales to illustrate their neuration. In each specimen the scaleless left fore and hind wings illustrated the neuration of the genus.

An experiment to ascertain the period at which larvæ are sensitive to surrounding colours, formed the subject of an exhibit by Prof. Poulton. The larvæ of *Amphidasis betularia* were, after hatching, surrounded with green leaves and shoots. During

each of the stages of growth a batch of larvæ was removed and surrounded by dark twigs, and at the end of the stage restored to the green leaves. By comparing the colours of the mature larvæ in the different batches, it is possible to determine the period of larval susceptibility.

The following forms of variation in butterflies of the genus *Heliconius*, of Tropical America were exhibited by Mr. W. F. H. Blandford. (1) Variation in *Heliconius erato*, L. There are three main types with the basal patch of the hind-wings, respectively, red, blue, or green. The green form is dominant in Panama; it occurs throughout Central America, but not in South America, except sparingly in Colombia and Venezuela. At Sao Paulo, on the Upper Amazons, the blue form alone occurs, or the basal patches may be obsolete. (2) Variation in *Heliconius thelxiope*, Hübn., and *Heliconius vesta*, Cram. Both forms occur together, and are very variable in Cayenne and the Lower Amazon Valley. Further west definite parallel geographical races occur of both. *Heliconius thelxiope* is connected by intermediate forms in Cayenne with *Heliconius melpomene*, L., a widely distributed species, which occurs in the Amazon Valley at Santarem and Obydos only, and is not found in the humid forest. In Bolivia *Heliconius vesta* merges into *Heliconius phyllis*.

Mr. W. Saville Kent showed interesting photographs and specimens illustrating the natural history and ethnology of Australia. The Hon. Walter Rothschild exhibited a group of recently described and other rare Birds of Paradise and Bower-birds.

During the evening four lantern demonstrations were given in the meeting room of the Society. Prof. A. C. Haddon showed a series of slides illustrating the evolution of the cart, and another which illustrated the evolution of the Irish jaunting-car. The Altels avalanche, which occurred in September 1895, was described with photographs by Dr. Tempest Anderson, and Prof. Herkomer gave a demonstration of his new gravure process. Prof. Dewar dealt with liquid air, and showed the following experiments illustrative of low temperature effects:—Filtering liquid air; vacuum vessels boiling at 350° F. below the freezing point; colour and absorption spectra; spheroidal state; solid alcohol; frozen soap-bubble; distilling mercury and phosphorus; liquefaction and solidification of gases; fusible metal spring; brittle indiarubber and its expansion by cold; the diamond burning in liquid oxygen; magnetic oxygen; photographic action and phosphorescence; ignition by means of a lens of liquid air; cooling a vessel 380° F. below the freezing point, until the air of the room condenses on the surface to the liquid state.

The Lords of the Committee of Council on Education have arranged for the public exhibition, in the Western Galleries of the Science Museum at South Kensington, of a number of the objects shown at the soirée. The exhibition will remain open to the public for about a fortnight.

ON THE ROTATION OF THE EARTH.[1]

THE recent discovery of periodical variations of terrestrial latitudes demands a revision of the actual theory of the rotation of our planet. This theory, based upon the hypothesis of the absolute rigidity of the earth, admits of variations of this kind, but very different in their laws from those of the observations. The period of revolution of the terrestrial poles given by the theory is one of about ten months. That which the observations give us lasts nearly fourteen months. Still further, the attentive analysis of the observations of the latitudes, executed of late by Mr. Chandler, shows us that the movement of the terrestrial poles is compounded of two others, of which the periods are, the one of 430 days, and the other of twelve months.

Following the order of the ideas established in the science by the celebrated cosmogenic hypothesis of Laplace, we ought to attribute this disagreement of the theory and the observations to the interior fluidity of the earth. But the illustrious physicist, Lord Kelvin, does not admit that the fluid nucleus of the earth may be of considerable enough dimensions. The greatest part of the astronomers of our day adhere to this opinion. They refer the said discordance to the terrestrial globe being elastic.

[1] Abridged translation of a paper by Th. Sloudski, Professor at the University of Moscow (*Bulletin de la Société Impériale des Naturalistes de Moscou*. Année 1895, No. 2).

In considering the hypothesis of a thin rigid crust of the earth as contrary to all given physics, the celebrated English physicist affirms in his memoir "On the Rigidity of the Earth," *Phil. Trans.*, 1863, and in the first edition of the "Treatise on Natural Philosophy" (§§ 847 and 848), that this hypothesis is also incompatible with the observations of the precession and of the nutation. On subsequently withdrawing certain of these astronomical objections, he has replaced them by some others.

To be able to appeal to objections of this kind, the theory of the rotation of the earth considered fluid in its interior ought to have been previously established. Lord Kelvin has not done it. He has limited himself to enunciating in general terms the principal propositions of this theory. To be able to judge of the said objections of the celebrated English physicist, the theory in question must be previously established.

The problem of the rotation of the earth—supposed fluid in its interior—was approached by W. Hopkins in 1839 (*Phil. Trans.*, 1839-40-42); but the state in which hydrodynamics then was found, did not permit the English savant to treat the matter in a satisfactory manner. The more recent attempts to solve this difficult problem have not been more successful.

We shall endeavour in the present article to give a more perfect solution of this important problem. To render this task more easy, we shall assume that the nucleus of the earth is homogeneous, and of the form of a planetary ellipsoid.

The success of our task is assured by the beautiful researches of our clever geometrician, Prof. N. Joukovsky, relative to the movement of a solid body with cavities filled with an incompressible homogeneous fluid. We have only to apply these researches to our special problem. We hope to lessen the difficulties of this application by the supposition that the rotatory motion of the entire terrestrial mass differs very little from the uniform rotation. The proposition of the celebrated Laplace, relative to the effect of friction of the fluid parts of the earth upon its rotatory motion, affords us a solid foundation for the said supposition ("Œuvres Complétes de Laplace," tome v. p. 283).

We shall commence our article with an abridged exposition of the theory of the rotation of a solid body, which has a cavity filled with an incompressible homogeneous fluid. In the development of the principal formulæ of this theory we shall employ the most simple method, that of the illustrious Poisson. We shall equally profit by them in our transformations of the hydrodynamical equations.

(The final paragraphs, after thirty large octavo pages of intricate mathematics, are as follows.)

We have taken our problem with some considerable restrictions relative to the form, to the position, to the structure, and to the movement of the terrestrial nucleus. This renders almost useless the detailed comparison of our results with the given astronomical ones. We will only say some words relative to one of these results, of which the generality is indubitable.

The hypothesis of a fluid nucleus of the earth being admitted, and the exterior forces neglected, the movement of the terrestrial poles ought to be composed of two periodic movements. The period of the former of these movements is perhaps of twelve or fourteen months, that of the second ought to be pretty nearly a day.

The astronomical observations do not show us this second movement of the poles. Is not this a reason for taking exception to the hypothesis of the fluidity of the earth in its interior? By no means. It is in the first place possible that the smallness of the amplitude of the movement in question may make it unrecognisable. The smallness of the factors μ_2, ν_2, renders this supposition probable. Secondly, it may also be admitted that the want of the appropriate observations causes us to ignore for the present this movement, although its amplitude may be appreciable. One may also suppose that the period of the movement in question, from the usual order of astronomical observations, appears to us to be a period of twelve or of fourteen months. For instance, should the said period be equal to twenty-four sidereal hours exactly, and the observations of the latitude of any astronomical observatory be made every midnight during a good many years, the result of them will be the period of twelve months.

This last supposition appears to us worthy of attention, because according to our opinion the explanation of the period of twelve months by meteorological causes, as is adopted at present by some astronomers, wants probability.

THE ANKLE-JOINT IN MAN, AND THE INHERITANCE OF ACQUIRED CHARACTERS.

PROF. RETZIUS has lately published an account of certain observations on the fœtus of Swedes, which, in connection with similar observations recorded by Surgeon Havelock Charles on the Punjabite, he believes to support the Lamarckian view that acquired characters are inherited. He endeavours to show that the evidence in support of the theory is to be found in our own skeletons.

Some years ago, Prof. Arthur Thomson pointed out that in certain races of men who habitually adopt a "squatting position," the tibia and astragalus present additional articular facets, allowing greater flexure of these bones upon one another, than is possible (or at any rate normal) in Europeans and other civilised races who have given up squatting, and in which these facets are absent. Accompanying these facets there is a retroversion of the head of the tibia. Both these characters are present in apes and in certain prehistoric races, and Surgeon Havelock Charles described, a year or two back, a series of instances of their presence not only in the adult Punjabite, but in the fœtus. At the meeting of the British Association at Oxford, Prof. A. Macalister exhibited these specimens, as well as similar specimens taken from British infants, and a discussion followed on the meaning of these peculiarities. Now Retzius ("Ueber die Vererbung erworbener Eigenschaften," *Biol. Untersuch*, n.f. vii.) records these same characters in fœtal Swedes, from an early age, even up to eight months; and reviewing the facts, he comes to the conclusion—in which I think most of us would agree—that the presence of these characters, viz. the retroversion of the head of the tibia and "Thomson's facets" is a more primitive condition than their absence in normal Europeans of the present day; that they have been inherited from early times; and in those peoples which habitually adopt the "squatting" position they have become gradually further developed. This last conclusion is perhaps open to question: it is quite possible that even in these races they are less developed than in ancestral forms. But Retzius proceeds to contend that Europeans have undergone gradual change in their skeletons from generation to generation; they no longer sit on their haunches, and have gradually lost the power to do so, and as a consequence "Thomson's facets" have disappeared; and he concludes that "it is, therefore, we Europeans who, on account of changed habits, have undergone changes, and it is in us that these changes have gradually been inherited."

But here, it seems to me, that Darwinians would join issue with Retzius. His own and other observations show that the *changes* are not inherited; for the characters of the bones are inherited from the ancestral ape-like forms, and it is, surely, only on account of individual habit that the peculiarities are not present in the adult.

It is by no means clear what is the "acquired" character on which Retzius hangs his views. Is it the osteological peculiarity, or the habit of using chairs to sit upon, instead of employing the squatting posture? His own researches show that the osteological characters are *not* acquired, whilst the habit of walking upright and sitting on chairs is distinctly acquired, and it is in relation to this acquirement that the osteological peculiarities cease to be evident. Young children, as we know, can and do sit upon their haunches, and can move their legs and ankles in a way that an adult, unless he is fairly athletic, finds it impossible to do; and it appears probable that the disappearance of the facets in the adult is closely connected with the ossification of the bone, which will obliterate the facets now no longer brought into use. It would be interesting to examine in this connection the leg-bones of "contortionists" and others who make a free use of their legs and ankles, for a very little practice enables even civilised men to employ exaggerated movements of their limbs.

Another point to which attention might be directed (which indeed may have been looked into) is the character of the articulation of the bones of the great toe in those races which make use of this digit. A casual observation on the skeleton of an Andaman shows that the articular surface of the first metatarsal with the entocuneiform is distinctly more rounded than in a European; a feature in which there is an approach to the condition in the apes. It might have been presumed that some difference, similar to that in Europeans and Punjabites, would be found in digitigrade and plantigrade mammals; but the result of a brief examination of skeletons of such forms is sufficiently surprising to be referred to; for instance, in the lion there is a facet of the same kind as, but not really homologous with Thomson's facet, at the lower end of the tibia. This is absent in the bear and the dog; it is also absent in the sea-otter. It is present, however, in the beaver and other rodents; it exists in some ruminants, as well as in the horse, but is only slightly developed in the tapir, and is absent in the Suidæ.

THE PARIS OBSERVATORY.

M. TISSERAND'S report on the work accomplished in the Paris Observatory during 1895 has come to hand. The principal points referred to are indicated in the subjoined summary.

The revision of the right ascensions of the fundamental stars of the Paris Catalogue is completed, and the revision of the polar distances was commenced in May of last year.

During the year, MM. Henry obtained 319 plates for the photographic star catalogue, which number brings the total up to 1155. Eighty-eight plates, containing 35,814 stars, were measured under the direction of Mlle. Klumpke, and the measures of 13,663 stars upon forty-three plates previously obtained were reduced for the catalogue of the photographic chart.

The great Coudé equatorial has been used whenever possible in lunar photography, in order to complete the series of photographs of the moon required to make a large-scale map of our satellite. The photographs already obtained have been enlarged and reproduced by heliogravure by MM. Fillon and Heuse. The first fasciculus of the photographic chart of the moon, which MM. Lœwy and Puiseux have in hand, containing six sheets, five of which will represent parts of the moon on a scale of 2·60 metres to the lunar diameter, will shortly be issued. The present report contains a heliogravure representing an unenlarged photograph of the moon obtained in February 1894. The picture is a most striking one, reproducing faithfully and beautifully the chief features of the lunar surface.

M. Deslandres has continued his photography of the solar chromosphere. He has also investigated the subject of the displacement in the lines of the spectrum of Jupiter, produced by the planet's rotation. A note upon this subject appeared in NATURE in March 1895 (vol. li. p. 443). In the first measures made by M. Deslandres, the equator of the planet was allowed to lie along the slit of the spectroscope, and the inclination of the lines produced by approach and recession of opposite ends of the equatorial diameter were determined. The method now followed consists in measuring the inclination of the lines in the planet's spectrum with reference to neighbouring lines of terrestrial origin. The mean of the measures thus made gives 48 ± 1 kilometres as the difference of velocity of two opposite points on Jupiter's equator. From the known time of rotation of the planet, and the length of the equatorial diameter, the velocity deduced is 49·6 kilometres. The same method has been applied by M. Deslandres to Saturn's disc and rings.

Reference is made to the spectroscopic photographs of the velocity of Altair in the line of sight. The photographs give evidence of differences in the radial velocity, even when the mean error of observation is considered. These variations have a period of about forty-three days, and a secondary period of about five days. The conclusion arrived at from an examination of the spectra is that Altair is in orbital motion under the influence of one or more unknown bodies. The star β Ursæ Minoris also shows variations of velocity in the line of sight which cannot be accounted for by errors of observation.

In addition to the matters referred to in the foregoing, the usual meridian work, and observations of comets and minor planets, as well as meteorological observations, were carried on during 1895, and the chief results obtained are stated in the report.

CABLE LAYING ON THE AMAZON RIVER.[1]

WHEN it had been decided to connect Belem, the capital of the State of Pará, by means of a subfluvial cable with Manaos, the capital of the State of Amazonas, a preliminary journey became necessary, during which landing-places at the various intermediate stations had to be selected, some reaches of the river explored, as no trustworthy charts exist, and various

[1] Abridged from a discourse delivered at the Royal Institution by Mr. Alexander Siemens.

other details ascertained in order to facilitate the laying of the cable.

This preliminary survey took place in October of last year during the hottest season, when the river was at its lowest; while the cable was laid during January and February of this year, when the rainy season had commenced and the river was rising.

It is extremely difficult to realise the true proportions of this river, but the subjoined comparative table, in which the dimensions of the principal rivers of the various continents are contrasted with those of the Amazon, will help to show the importance of this great system of natural waterways.

With several other large rivers the Amazon shares the fate that its name changes several times during its long course, and that at various times different affluents have been considered to be the true source of the main stream.

Most geographers, however, regard the Marañon as the principal river, a branch of which, called Tunguragua, rises in Lake Lauricocha in Peru in 10° 30′ S. lat., and 76° 10′ W. long.; although the Ucayale, where it unites with the Marañon at Nauta (4° S. lat., 73° W. long), is quite as important as the Marañon.

Name.	Length in statute miles.	Watershed. Square miles.	Average discharge cubic feet per second.	Length of navigable waters in miles.
Mississippi ...	2616 [1]	1,285,300 [6]	675,000	35,000
La Plata ...	2400	994,900 [6]	700,000?	20,000
St. Lawrence	2200	565,200 [6]	1,000,000 [7]?	2,536
Nile	3370	1,293,050 [6]	61,500	3,000 [3]
Volga	2325	592,300 [6]	384,000 [2]	14,600
Danube ...	1735	320,300 [6]	205,900	1,600 [3]
Rhine	810	32,600 [6]		550 [3]
Thames ...	210	6,010	2,220 [4]	200 [3]
Amazon ...	2730 [5]	2,229,900 [6]	2,400,000	50,000

(1) To source of Missouri 4300 miles.
(2) At Saratoff.
(3) Exclusive of tributaries.
(4) At Teddington.
(5) To source of Apurimac 3415 miles.
(6) According to Dr. John Murray.
(7) According to Darby, the American hydrographer.
According to *Encyc. Britt.*

Area of Great Britain and Ireland	120,626
,, British India	1,560,160
,, Brazil	3,219,000
,, Europe	3,790,000

If the greatest distance from the mouth is to decide the question, then the source of the Apurimac, an affluent of the Ucayale, can lay claim to being the origin of the Amazon, rising in Peru in 16° S. lat., and 72° W. long.

Along the whole course of the Amazon, commencing at the foot of the Andes, a network of islands and canals is formed on both sides of the river, as the whole country is almost level, and is consequently inundated during the rainy season for hundreds of miles by the rivers flowing through it. The most notable exception to this general state of things occurs at Obidos, where the whole volume of water is compressed into one channel a little over a mile wide, and said to be about forty fathoms in average depth. A sounding taken opposite Obidos, about a third of the distance across the river, showed a depth of fifty-eight fathoms, measured by a steel wire and Lord Kelvin's sounding-machine. As the current of the river averages three knots in the main channel, it is not easy to take soundings by an ordinary lead line; and even with the steel wire an extra heavy weight (33 lb.) has to be employed, or the results are not trustworthy.

Besides the wire sounding-machine a submarine sentinel was used on the preliminary voyage, wherever serious doubts existed about a channel through which the cable was to be laid. This apparatus consists of a small winch from which a wire leads into the water and drags at a short distance behind a piece of wood, shaped like an angle-iron, in a nearly upright position. The wire is not attached directly to the piece of wood, but to a string kite-fashion, and the wood is fitted with an iron foot which, on coming in contact with the bottom of the water, releases one end of the kite-string, so that the wood remains attached to the winch wire with one end only. The consequence is that the strain on the wire is suddenly reduced to a very small amount, and the piece of wood appears on the surface of the river. It depends on the quantity of wire paid out how deep the kite or the sentinel floats, and its action is quite trustworthy, so that it is unnecessary to take soundings by the line or by wire while the sentinel is being dragged by the ship. Usually the sentinel was set at five fathoms, and when it struck a bar the ship was stopped, and a series of soundings taken to ascertain the exact depth of water, and the extent of the shallow place.

A further difficulty in sounding originated from the soft nature of the soil, which for the greater part of the Amazon valley is alluvial clay, and allows the lead to sink into it for several feet. In the narrows there appears, however, a bank of hard clay (called Tabainga) which, unfortunately, blocks nearly all the branches of the narrows, and creates bars all along the course of the Tajipuru, the main westerly waterway connecting to the Gurupá branch of the main river. Occasionally the same hard clay forms shallows in the main river, but as a rule the section of all the channels resembles the capital letter U, *i.e.* the sides are very steep and the bottom flat. In this respect, as in many others, the Amazon differs entirely from the Indian rivers, which build up their beds above the surrounding country, occasionally breaking through their natural banks and seeking a new bed. The Amazon, on the other hand, carries with it only the light clay sediment which forms the soil of the whole valley; and the inducement for the main stream to alter its course is therefore very small, and long straight reaches are the result.

Under these circumstances the largest vessels can ascend the river nearly to the foot of the Andes, but the constantly-changing sandbanks at the mouth of the Amazon proper make this approach of the river dangerous, and the State of Pará is, for obvious reasons, not over-anxious to have the deep channels properly buoyed and surveyed. This forces all the shipping to enter the Pará River, and to pass the narrows if the Amazon is the goal of the journey. In doing the latter, the choice for large ships lies between one of the channels (called Furos) with a bar, where it joins the Tajipuru, and a furo (the Macajubim) which has plenty of water, but which winds about in such a serpentine fashion that only ships with twin screws can pass it unassisted.

These difficulties are, however, much diminished during the rainy season, when the river rises to such an extent as to drive all the inhabitants of its banks into the towns, which have been built wherever a natural eminence secured the inhabitants against the flood. Near the mouth the difference is naturally not so great as higher up, where the influence of the tide is felt less; but at Manaos the difference in level between low river and high river exceeds forty feet.

With all rivers carrying sediment the Amazon shares the peculiarity that its immediate banks are higher than the country lying behind them, and thus we have in the rainy season the spectacle of the main river flowing between two banks covered with dense forest, and immense lakes stretching out on either side of these banks. These do not entirely dry up during the remainder of the year, so that the whole of the Amazon valley really forms a huge swamp covered with a most luxuriant forest, which below Manaos narrows to a broad belt close to the main river with prairies, called Campos, at the back of the forest stretching out to the hills, where the forest recommences. In such a country no land communication of any sort can be attempted, as the tropical vegetation and the annual inundations of the rivers destroy everything that man places in the way of the natural forces. By water, on the other hand, the intercourse between all habitable parts of the country is easy and expeditious since steamers were introduced in the year 1853. Belem, the capital of the State of Pará, lies on a branch of the Pará River, called Guajará, which unfortunately does not share the characteristic shape of the Amazon and the furos, but forms a rather shallow basin in front of the town.

The first station on the main cable is Breves, the centre of the rubber trade of the islands of the lower Amazon, situate in the centre of "the narrows."

In Gurupá, the second station of the main line, the inhabitants expressed their joy at being put in communication with the rest of the world by actively helping in the landing of the first shore end.

During an enforced sojourn near the mouth of the Boinasu, in the midst of the most wonderful combination of islands and rivers, the two naturalists, which the British Museum authorities had kindly sent with the expedition, took full advantage of the opportunity to explore the locality in all directions.

In the rubber-gathering industry, which is at once the wealth and bane of this part of the world, the implements in use are of the most primitive kind, but the average earnings can easily be three pounds per day during the dry season, and the facility of earning so much money with little exertion makes the inhabitants unwilling to engage in more arduous labour.

A narrow path leads from the hut on the water's edge into the forest from one rubber-tree to another, the path eventually returning to the hut. The trees are cut on the morning round, and the rubber is gathered in the afternoon. As soon as it arrives at the hut a fire of oily palm-nuts (*Attalea excelsa*) is lighted, and the thin sap thickened in the smoke For this purpose a paddle is used, on to which the sap is poured with a small earthenware or tin vessel. The smoke soon thickens it, and a new layer is poured on until the well-known flat cakes of india-rubber have been formed.

Owing to the rise of the river during the rainy season most of the huts have to be abandoned, and it can easily be imagined how comfortless they are. Nearly all of them are built on piles, and most of them are thatched with palm-leaves. There is hardly any attempt made to cultivate the soil, such as it is, but everything is imported. The s.s. *Cametense*, in which the surveying party went out, was laden with cabbages, onions, and potatoes, part of which went as far as Iquitos in Peru.

Chiefly owing to this want of provisions, and to the generally careless mode of life, the mortality among india-rubber gatherers is very great.

Everything Bates and Wallace have said of this region remains as true as it was forty years ago, and hardly anything new can be added to their description of the general features of the Amazon valley; but the town of Manaos has completely changed its character since it was made the capital of that region in 1853. A town quite European in its features has arisen in the midst of the forest, and to the benefits of rapid transport, to which it has owed so much, there is now added the characteristic lever of modern progress, the annihilator of space and time—electrical communication.

NOTES ON CLOUDS.[1]

THERE are two points connected with clouds on which I wish to make a few remarks. The first is on the classification of clouds, and the second on the manner in which certain forms of clouds are produced. It may be as well to remark at the outset that the observations are those of an "outsider," being in a department of meteorology to which I have given but little attention, and they have been written with a view of calling the attention of specialists, and getting their opinion on the subject.

It appears to me that in classifying clouds they ought first of all to be divided into two great classes. In the one class should be placed all clouds in the process of *formation*, and in the other those in the process of *decay*. The two classes might be called *Clouds in Formation* and *Clouds in Decay*. We may take Cumulus clouds as an example of the former, and Nimbus of the latter. My observations made on the clouds themselves have shown that there is a difference in the structure of these two classes of clouds. In clouds in formation the water particles are much smaller and far more numerous than in clouds in decay; and while the particles in clouds in decay are large enough to be seen with the unaided eye when they fall on a properly lighted micrometer, they are so small in clouds in formation that, if the condensation is taking place rapidly, the particles cannot be seen without the aid of a lens of considerable magnifying power. In the former case the number of particles falling per square millimetre is small, while in the latter they are so numerous that it is impossible to count them.

It appears that one good end might be served by adopting this classification. It would direct the attention of observers more to looking on the processes going on in *decay* for an explanation of many of the forms observed in clouds. In most books on clouds, when describing the different shapes of clouds, it is almost always assumed that they are in process of *formation*, and the whole explanation of the shapes taken by the clouds is founded on this supposition. Now, it is very evident that very many clouds are in the process of decay, and their forms can only be explained by the processes going on under these conditions.

This brings me to the second point in this communication, namely, the manner in which ripple-marked cirrus clouds are produced. The explanation which has generally been accepted of the formation of this form of cloud is, that the ripple markings are due to the general movements of the air giving rise to a series of eddies, the axes of the eddies being horizontal, and roughly parallel to each other. It is very evident that the air revolving round these horizontal axes, that is, in a vertical plane, will at the lower part of its path be subjected to compression, and at the upper part to expansion. The result of this will evidently be, supposing the air to be nearly saturated with moisture, a tendency for cloudy condensation to take place in the air at the upper part of its path, and it is this cloudy condensation in the upper part of the eddies that is supposed to produce the ripple-like cirrus; each ripple mark indicating the upper part of an eddy. One objection I have always felt to this explanation is, that it is difficult to imagine that the small amount of elevation and consequent expansion and cooling could give rise to so dense an amount of clouding as is generally observed. Any clouding produced in this way one would expect to be extremely thin and filmy. I have for the last few years made frequent observations of these clouds, and I have to admit I have never once seen them in the process of formation, or seen one appear in a clear sky. In all cases that have come under my observation, these ripple clouds have been clouds in decay. They are generally formed out of some strato-cirrus or similar cloud. When we observe these strato-cirrus clouds in fine weather, it will be found that they frequently change to ripple-marked cirrus clouds before vanishing. The process of their formation would seem to be: the strato-cirrus gradually thins away till it attains such a depth, that if there are any eddies at its level, the eddies break the stratus cloud up into parallel or nearly parallel masses, the clear air being drawn in between the eddies. It will be observed that this explanation requires the eddies, but not to produce the clouding, only to explain the breaking up of the uniform cirrus cloud into ripple cirrus.

One thing which supports this explanation is, that lenticular-cirrus clouds are frequently observed with ripple markings on one or more sides of them just where the cloud is thin enough to be broken through by the eddies. If we watch these lenticular-formed clouds under these conditions, we frequently see the ripple markings getting nearer and nearer the centre as the cloud decays; and at last, when nearly dissolved, the ripple markings will be seen extending quite across the cloud. It seems probable that "mackerel" and other cloud forms may be produced in the same way.

The shapes which these ripple cirrus clouds assume are much more varied than is generally supposed. I lately observed a most interesting form in the south of France while the mistral was blowing strongly. There were a few cirrus clouds in the sky at the time, and one of these was rapidly being broken up into irregular ripple forms, but at one point there was formed a most perfectly cylindrical-shaped piece, its length being about twenty times its diameter. The whirling effect of the eddy was very evident by the circular streaking of the clouding. Further, this cloud was evidently hollow, that is, the interior was filled with clear air as the cloud was thinnest along the axis, and it had all the appearance of a revolving tube of cloudy air.

It is not contended here that ripple clouds are never produced in the manner which has generally been accepted, only that so far as my observations go they have never been observed forming in the manner supposed. It is hoped that others will put the explanation here offered to the test of observation, and it is principally with a view of getting others to repeat the observations that this has been written.

[1] Paper read by John Aitken, F.R.S., to the Roy. Soc. of Edin. on May 4.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—In the Mathematical Tripos List published on June 16, Mr. W. G. Fraser, of Queens', is Senior Wrangler, Messrs. Barnes, Carson, and Wilkinson, all of Trinity, are bracketed for the second place, and four members of St. John's, Messrs. Edwardes, Houston, Cook, and Turner, follow in two brackets, fifth and seventh. Miss Longbottom, of Girton, has the twelfth place.

In Part II. seven names appear in the first division of the first class, beginning with Mr. Bromwich, of St. John's, the Senior Wrangler of last year.

Mr. A. C. Dixon, of Trinity College, has been approved for the degree of Doctor of Science, in consideration of his mathe-

matical works. Mr. Dixon was Senior Wrangler in 1886, and is Professor of Mathematics at Galway.

A lectureship in Hausa is about to be founded, in virtue of a benefaction by the Hausa Association. The language ranks with Arabic and Suaheli as one of the most important West African tongues used within the British sphere of influence.

The General Board propose that a Professorship of Mental Philosophy and Logic, with a stipend of £700 a year, should be forthwith established. Prof. Sidgwick has generously offered to accept a diminished stipend of £500 a year for the next six years in order that funds may be available for this purpose.

The Tyson Medal for Astronomy has been awarded to Mr. E. T. Whitaker, of Trinity.

Mr. W. Mather has received the thanks of the University for a valuable gift to the Engineering Laboratory of an experimental steam-engine and dynamo.

A Latin letter of congratulation to Lord Kelvin on the jubilee of his Professorship at Glasgow was approved at the Congregation on June 11, and was ordered to be sealed with the Common Seal of the University and presented to him by the University delegates to Glasgow.

The Syndicate on Women's degrees was appointed without opposition, and have already held their first meeting. Their report will not be issued until next Term.

The following appointments have been made in the Northern Polytechnic Institute, Holloway:—Mr. Hubert A. Garratt, Senior Lecturer in Engineering, University College, Bristol, to be Head of the Engineering Department; Mr. V. A. Mundella, Assistant Lecturer in Physics and Electrical Engineering, Durham College of Science, Newcastle, to be Head of the Physics and Electrical Engineering Department; Dr. Thomas Ewan, Assistant Lecturer in Chemistry, the Yorkshire College, Leeds, to be Chief Assistant in the Chemical Department. Other recent appointments are:—Dr. G. Frege to be Professor of Mathematics at Jena; Dr. Lickfett to be Director of the Hygienic-bacteriological Institute at Danzig; Dr. Scholl to be Extraordinary Professor of Chemistry in the Technical High School at Karlsruhe. Mr. E. A. Gardner, formerly Director of the British School at Athens, to be Yates Professor of Archæology in University College, London; Dr. Paul Eisler to be Extraordinary Professor of Anatomy at Halle; Dr. L. Joubin to be Professor of Zoology, and Dr. H. Prous to be Extraordinary Professor in Lille University; Dr. Theobald Smith to be Professor of Comparative Pathology in Harvard University.

The Technical Instruction Committee of the North Riding County Council some time ago substituted a system of individual instruction in cheese and butter making at the farm-house of any farmer who desired it, for the more commonly adopted travelling dairy school. In addition to this method of instruction they have agreed to a scheme whereby a permanent dairy school will be opened at Helmsley in the course of the present month. The school is being built by the Earl of Feversham, and is to be placed at the Committee's disposal, who are making themselves responsible for the proper fittings and apparatus. It is confidently anticipated that the school, which will be styled the "Ryedale Dairy School," will be much used and greatly appreciated.

On Thursday evening last it was resolved by 332 votes to 83, that boroughs of not less than 20,000 population should form separate educational authorities. This will mean, as the Vice-President of the Council pointed out in his speech on this amendment, that in addition to the 128 authorities which there would have been as the Bill originally stood, we are to have 241 more authorities added, that is, provided the amendment passes the House of Lords. Further, since there is no doubt populous urban districts will claim to be treated like municipal boroughs, and it seems only reasonable to suppose that such will be granted similar powers, forty-nine more authorities will be brought in, making a total of 418 separate centres for the Education Department to deal with. In some cases the result will be extraordinary; for example, in Lancashire there will be some forty-two different educational authorities. The extent to which the work of the County Councils would suffer should this concession of the Government become law, can only be appreciated by those who know the spirit in which small local authorities approach any matters pertaining to secondary education.

SOCIETIES AND ACADEMIES.

London.

Physical Society, June 12.—Captain Abney, F.R.S., President, in the chair.—Mr. Campbell read a paper on the measurement of very large and of very small alternating currents. The author advocates the use of air-coil transformers for measuring voltages and currents which are either above or below the range of the instruments available. If an attempt is made to measure the current in the primary of an air-coil transformer by observing the voltage on an open circuit secondary, it is found that the readings depend on the frequency. In order to overcome this difficulty the author uses a closed secondary with a very high inductance. In this case the primary current is proportional to the secondary current, which latter may be measured by an ammeter. The author has also investigated the case of transformers with iron cores, and of which the inductance of the secondary is large. In the case of a ring transformer with a closed magnetic circuit, if the load on the secondary consisted solely of a Kelvin 100-ampere balance of very low resistance, the ratio between the primary and secondary currents is practically constant. With an open magnetic circuit transformer, however, this is not found to be so, as the ratio between the primary and secondary current varies considerably with the frequency. Mr. Blakesley said that the author's arrangement could only be used for measuring the *current* in the primary. He (Mr. Blakesley) had shown how to measure alternating currents by means of dynamometers, and without the necessity for any special apparatus. Mr. Griffiths exhibited and described his improved form of resistance box. This resistance box has many novel features: (1) It permits of all the coils being compared with one another, without the use of standard coils, and with great ease and rapidity. Hence it is sufficient at any time to compare any one of the coils with a standard to obtain the correction to be applied to all the coils. (2) The bridge wire can be calibrated by means of the box itself. (3) The temperature of the coils can be accurately determined, since they consist of bare platinum-silver wire wound on mica and immersed in an oil bath, which bath is kept stirred. (4) The resistance of the leads from the box to the object being tested is eliminated, as well as any error due to a change in this resistance with temperature. (5) The coils are arranged according to a binary scale, and the author claims that it is possible to measure resistances up to 105 ohms, to within 0·000001 ohm. (6) All the coils, after being adjusted, have been heated to redness and allowed to cool slowly, so that all strain has been removed from the wire. (7) By having a separate pair of blocks for each plug, it is impossible for the insertion of one plug to affect the fit of a neighbouring plug. The plugs themselves are so made that no part of the plug is wider than the top of the hole, and so it is impossible to wear a "shoulder" on the plug. Prof. A Gray said that Mr. Griffiths had discovered and remedied all the weak points of the ordinary form of bridge. Lord Kelvin had ordered the paraffin to be melted off the coils of one of his resistance boxes, and it was found that the resistance of the coils altered considerably, owing, no doubt, to the strain to which the wire had been subjected, when imbedded in the solid paraffin. Lord Kelvin had made coils without paraffin, and was specially in favour of the use of the binary scale. Prof. S. P. Thompson said he considered the binary scale the weak point of the author's arrangement, since it did not permit of ratios other than 1 to 1 being employed. Mr. Campbell asked what current could safely be passed through the coils. The author in his reply said that he believed it to be a great mistake to employ any ratio for the arms other than 1 to 1.—Prof. S. P. Thompson read a communication on Röntgen rays. The author, after describing the various forms of tubes he had made with a view of discovering the best form for the production of Röntgen rays, gave an account of the experiments he had made to try and obtain some indication of polarisation. In this connection a large number of crystals have been tested, but the experiments have all given negative results. The author exhibited an electroscope with aluminium leaves and enclosed in a wire-gauze screen, to protect it from the influence of outside electric changes, by means of which he was able to show the discharge of a positively or negatively electrified body by means of the X-rays. A method of obtaining dust figures by the discharge of an electrified body by the X-rays

was shown, and some of the results which have been obtained were exhibited. All attempts to obtain true reflection have failed, although it appears as if most bodies, including air, are capable of giving diffuse reflection.—Dr. Shettle, who was announced to give a paper on Röntgen rays, explained that he had just discovered that the effects he had intended to describe were due to red light which had penetrated his dark room.—Prof. du Bois said that Galitzine had found that Röntgen rays were polarised by tourmaline, a special form of developer being employed. The behaviour of tourmaline to light waves presents some curious features, for if the wave-length is increased a point is at length reached where the ordinary and extraordinary rays are equally absorbed. For greater wave-lengths the ordinary conditions are reversed. If the Röntgen rays are not homogeneous, the contradictory results obtained by different observers might be due to the fact that they were working with rays which were differently absorbed by tourmaline.—Mr. Swinton said he had tried the effect of heating the kathode, and had obtained results which were similar to those obtained by the author. Mr. Swinton further said that he had found that the blue luminescence sometimes observed depended on the size of the kathode. With tubes in which the kathode was almost a complete hemisphere it was impossible to eliminate this blue luminescence.—Mr. Appleyard suggested the performance of the experiments under the surface of a dielectric.—Prof. Gray said he had obtained some indication of regular reflection, but nothing definite. The author in his reply said that it had been found that if the Röntgen rays are reflected from a surface of sodium in vacuo the amount reflected is a minimum for normal incidence, and increases at oblique incidence. Comparing this behaviour with that of ultra-violet light, it supports the idea that the Röntgen rays consist of transverse vibrations. The Society then adjourned till June 26.

Geological Society, May 27.—Dr. Henry Hicks, F.R.S., President, in the chair.—The President announced that a portrait in oils of the late Prof. Huxley had been presented to the Society by Sir John Evans, K.C.B., F.R.S.—On the Pliocene deposits of Holland, and their relation to the English and Belgian crags, with a suggestion for the establishment of a new zone "Amstelien," and some remarks on the geographical conditions of the Pliocene epoch in Northern Europe, by F. W. Harmer. The author drew attention to some papers by Dr. J. Lorié, of Utrecht, describing the strata met with in some deep borings in Holland, which showed that the Newer Pliocene is in that country nearly 500 feet thick, and that it had been depressed more than 1000 feet below its original position. He inquired whether this subsidence could be connected with the elevation of the Older Pliocene in Belgium and Kent, and how far these earth-movements could be traced in East Anglia and influenced the deposition of the English crag. He gave particulars of the alterations in level which have taken place during and since the Crag period in England and on the continent, showing that the two movements of upheaval and subsidence have much in common, and especially that they regularly increase in degree to the north and south respectively.—The *Lingula*-flags and igneous rocks of the neighbourhood of Dolgelly, by Philip Lake and S. H. Reynolds.—The Kildare inlier, by S. H. Reynolds and C. I. Gardiner. The area described in this paper is occupied by four prominent hills composed of lower palæozoic rocks rising as an inlier from beneath carboniferous beds. The authors gave the following succession of rocks in descending order. (6) Green and grey micaceous grits and shales of Dunmurry. (5) Red and black shales. Gap: no exposure seen. (4) Limestones of the chair of Kildare. (3) Contemporaneous igneous rocks. (2) Fossiliferous ash of Grange Hill House. (1) Green gritty shales (unfossiliferous).

CAMBRIDGE.

Philosophical Society, May 25.—(*a*) On the spectroscope used in connection with the 25-inch refractor; (*b*) on a suggestion for a form of spectroheliograph, by Mr. H. F. Newall. On the period of the earth's free Eulerian precession, by Mr. J. Larmor. The following general proposition is easily established; it has been suggested by the recent memoirs of Prof. Newcomb and Mr. Hough. Consider any solid body, for example the earth, in rotation about its axis of greatest moment of inertia: when the body is not absolutely rigid, the period of the small free precessional motions of the axis of rotation will depend in part on its elastic yielding to the centrifugal force; but in all such cases, whether the body is homogeneous or not, whether the elasticity is perfect or imperfect, this precessional motion will be the same as that of a body absolutely rigid, with its materials distributed in the configuration which the actual body would assume, on the supposition that it remains perfectly elastic, were it relieved of the centrifugal force of rotation. Taking the case of the earth, in which the equatorial moments of inertia are all equal to A, while the axial one is C, the ordinary forced astronomical precessions give the value of $(C-A)/C$; while knowledge of the variation of terrestrial gravity gives $C-A$; so that C and A are separately known. The period of the free Eulerian precession gives $(C'-A')/A'$, where C' and A' are the moments of inertia which the earth would have were the strain corresponding to centrifugal force removed. In so far then as this free period can be reliably disentangled from the actual observations of changes of latitude, which are also affected by unknown irregular variations due to meteorological causes, and so more or less of an annual character, we derive from it a knowledge of $C'-A'$; thereby obtaining an additional *datum* for discussions relating to the constitution of the earth's interior. This is on the supposition that the earth is wholly solid. The influence of the surface waters can, however, be estimated by the same principle, as they are in the main deep enough to make an equilibrium theory applicable. It appears that, if the actual earth were absolutely rigid, and wholly covered by an ocean, the mobility of this ocean would lengthen the period of free precession by about 14 per cent. But this superior limit is reduced both by the limited extent of the ocean and by the yielding of the solid earth; so that, on an outside estimate, not more than 6 or 8 of the actual 40 per cent. of lengthening of the period can be due to mobility of the surface waters. On this equilibrium theory, an amplitude of a third of a second of arc in the Eulerian precession would produce a tidal component, of the same period, whose amplitude would in middle latitudes be about half an inch; which is just the kind of result that has been derived from examination of the tidal observations in Holland and on the east and west coasts of North America. The influence of possible fluidity of a portion of the interior has been fully developed by Mr. Hough, the results agreeing with indications virtually given by Lord Kelvin so long ago as 1876, and published in the British Association Report for that year. The conclusion drawn by Mr. Hough from the Chandler period, that, for the small stresses involved, the interior of the earth is in the main perfectly elastic and about as rigid as steel, is in accord with the recent observations by seismologists of what is probably the time of propagation of earthquake disturbances from Japan to Europe in a direct line across the earth's interior.—Note on a point in theoretical dynamics, by Sir Robert Ball. Let α be a screw about which a free rigid body is made to twist in consequence of an impulsive wrench administered on some other screw η. Except in the case where α and η are reciprocal it will always be possible (in many different ways) to design and place a rigid body so that two arbitrarily chosen screws α and η will possess the required relation. Let now β and ζ be two other screws (not reciprocal); we may consider the question as to whether a rigid body can be designed and placed so that α shall be the instantaneous screw corresponding to η as an impulsive screw, while β bears the same relation to ζ. It is easy to see that it will not generally be possible for α, β, η, ζ to stand in the required relations; they must in some way be restricted. It is the object of the author's note to show that the restrictions are two in number, and to set down what they are.

EDINBURGH.

Royal Society, June 1.—Prof. Copeland in the chair.—Prof. Tait read a paper on the linear and vector function. We speak of fluid motion as being "differentially irrotational" when there is a velocity potential, and as "rotational" when there is a vortex. In the first case, the strain involved is pure, *i.e.* there are three rows of particles, at right angles to one another, whose directions are momentarily unchanged. In the second case, one such row of particles alone exists. But there is, when we look at the matter from the point of view of the roots of the strain-cubic, a third case—where there are three rows of particles, *not* generally at right angles to one another. Prof. Tait showed that such a strain is, in general, the result of the superposition of two successively applied, but different, pure strains. Thus, comparing the non-vortex states of a small element of a fluid at three successive instants, a portion, cubical at the instant A, may be found, such as to be brick-shaped, without change of direction of its edges, at B. Similarly from B to C. But to

compare A with C, we have a definite parallelepiped whose edges remain unchanged in direction.—Mr. R. C. Mossman gave the first part of a communication on the meteorology of Edinburgh, in which he dealt with the mean values of the climatic elements for each day of the year, basing his inquiry on over a million observations. The non-instrumental records extended over 125 years, and the daily sunshine means over 30, the average of the nineteen classes of observation being about 80 years. As regards pressure, the maximum was from April 7 to July 3, and the minimum on November 26. For temperature the maximum was an average of 59°·3 on August 8, while January 8 was the coldest, the mean temperature being 36·0. The curve of rainfall showed that the seven days ending April 18 were the wettest days in the year, thus confirming the popular belief in the Lammas floods. Mr. Mossman described in detail the climatic features of each month, and showed how these reacted on each other. An interesting result was the recurrence of similar types of weather at the same time each year.—Mr. Malcolm Laurie read a paper on the nutrition of the embryo in scorpions. The variation in the modes of development in different genera of scorpions is very large. The primitive form seems to be a large egg with much food yolk, and is found in *Euscorpius* and the *Buthidæ*. This egg develops in the ovarian tube. In other *Juridæ* the egg is yolkless, though appearing to be a considerable size owing to the surrounding embryonic membranes. In the *Scorpionidæ* the egg is entirely without yolk, and develops in a diverticulum of the ovarian tube. Various contrivances exist for the better nourishment of the embryo during the later stages of development. Nourishment, secreted by the cells of the diverticulum and by a solid cord of cells (appendix) in which it terminates, is always taken in through the mouth, which is early developed. In addition to this, in *Ischnurus*, the cheliceræ grow into long root-like processes which lie among the cells of the appendix, and seem to absorb nourishment from them. In *Hormurus* a similar function is performed by the chelæ, while in the *Scorpionini* the cheliceræ grasp a cord of cells coming from the centre of the appendix, and masticate it. In these last forms there are also present dorso-lateral out-growths of the segments of the body, which appear to act as surfaces for absorbing nourishment directly from the surrounding maternal tissues. This arrangement is carried still further in *Opisthophthalmus*, where there are two long processes, one from the prostomium, and the other from the back of the carapace, which run out among the maternal tissues.

DUBLIN.

Royal Irish Academy, June 8.—Dr. J. Kells Ingram, Vice-President, in the chair.—Mr. Charles J. Joly read a paper on quaternion invariants of linear vector functions and quaternion determinants. This was a supplement to a paper read before the Academy in December 1895, and published in their *Transactions* (vol. xxx. part 18). From given linear vector functions others are derived by repeated multiplication in any order. The Hamiltonian and other quaternion invariants of these new functions are expressed as the quotients of two determinants with vector constituents. Their scalar parts having been considered in the previous paper, their vector parts are now reduced to the results of operation on the spin-vectors of the given functions, and of one function of each of certain cyclical groups of the derived functions. Examples and interpretations are also given of determinants with quaternion constituents in the expansion of which the order of the rows is preserved.—Mr. Henry Dixon read a paper on the osmotic pressures in the cells of leaves. The method adopted for estimating the osmotic pressures existing in the cells of leaves, consisted in enclosing a branch bearing a number of leaves in a strong glass cylinder, capable of resisting high gas pressures (*e.g.* 50–100 atmospheres). The ends of this cylinder consist of stout brass castings, drawn together on the cylinder by means of bolts and nuts. The upper end is furnished with suitable couplings for connection with an air compression pump or an iron bottle containing liquid CO_2. The lower end is perforated and admits of the branch, to be experimented with, being sealed into it. The cut end of the branch dips into a vessel containing a weighed amount of water, which is placed below the glass cylinder. When the pressure in the cylinder is raised, it is found, that at a certain pressure, the leaves begin to collapse and lose their turgescence, and that water is forced down from them into the vessel beneath. By a series of experiments on each branch, a certain critical pressure is found which just balances the osmotic pressure of the cells, but which neither causes their collapse nor permits of their drawing up water from below.

PARIS.

Academy of Sciences, June 8.—M. A. Cornu in the chair.—Theory of the flow of water in conduits, by M. J. Boussinesq.—On the effect produced by the ring in iron in dynamo-electric machines. Reply to the note of M. Potier, by M. Marcel-Deprez.—Study of melted vanadium and its carbide. by M. H. Moissan. Vanadium pentoxide, reduced by carbon in the electric furnace, yields an ingot of metal which always contains an appreciable amount of carbon. If the time of heating is as short as possible, a metal containing only 5 per cent. of carbon can be obtained; by prolonging the time of heating the percentage of carbon increased to 18·5 per cent., indicating the formation of the carbide VC. The carbide is not attacked by water at the ordinary temperature. Vanadium forms alloys with iron, copper, and aluminium, but not with silver.—On a new method of preparing alloys, by M. H. Moissan. Alloys of refractory metals can be prepared by projecting a mixture of the oxide with powdered aluminium into a bath of liquid aluminium. The heat set free by the oxidation of the aluminium is sufficient to carry on the reaction. Alloys of aluminium with nickel, molybdenum, tungsten, uranium and titanium have been obtained in this way.—On the nature of the chemical processes involved in muscular action, by M. A. Chauveau. Summing up the results of a series of experimental researches on the relation between the energy given out as muscular work and the energy absorbed as food.—On the value as food of bread made from screened flours, by M. A. Girard. Analyses of flours of various qualities, from which the conclusion is drawn that the ideas generally held concerning the inferior nutritive power of fine white bread as compared with brown bread, are fallacious; both kinds of bread containing practically identical amounts of gluten and of phosphates.—On the theory of gases, a letter from M. Boltzmann to M. Bertrand, continuing the discussion concerning the validity of Maxwell's formula for the distribution of the velocities of the molecules at a given instant.—Reply to the preceding by M. Bertrand, by whom Maxwell's theorem is held to be obviously inaccurate.—The influence of the temperature of the freezing mixture upon cryoscopic measurements, by M. F. M. Raoult. Starting from simple considerations an expression is obtained giving a correction for super-cooling in cryoscopic measurements. This formula is identical with that given by MM. Nernst and Abegg, but the practical application of it given by the latter, is open to criticism. A very simple and accurate method is given by M. Raoult, who shows that the temperature of the bath is without practical effect upon the laws previously published. In the few cases where the correction is necessary, it is easily measured and applied.—On differential equations of the first order, by M. P. Painlevé.—On the regulation of motors, by M. L. Lecornu.—Observations on the errors due to variations of temperature in geodesic instruments, by H. F. A. Aimo. A discussion of the effect of temperature upon the size and shape of the air-bubble in levelling instruments.—On the spectra of metalloids in fused salts, by M. A. de Gramont. Measurements of the lines due to sulphur in metallic sulphides.—Contributions to the study of absorption by porous bodies, by M. Lachaud. An experimental study of the amounts of quinine, methyl-violet, salicylic acid, tannin, dextrine, and gelatine remaining in solution after treatment with animal black.—On the estimation of potassium, by M. Charles Fabre. The platinochloride is reduced in warm aqueous solution by magnesium powder, and the resulting chloride titrated with standard silver solution.—On the heat of vaporisation of formic acid, by Miss D. Marshall. By comparison with benzene as a standard substance, the value for the latent heat of vaporisation of formic acid was found to be 120·4, a number practically identical with that (120·9) calculated from M. Raoult's formula containing the rate of variation of vapour pressure with temperature, the absolute boiling point, and the molecular lowering of the vapour pressure as the experimental data.—Combinations of antipyrin with oxybenzoic acids and their derivatives, by MM. G. Patein and E. Dufau.—On lighting by acetylene, by M. G. Trouvé. A description of the methods used for the practical preparation of acetylene for lighting purposes from calcium carbide.—On the composition of the red pigment of *Amanita muscaria*, by M. A. B. Griffiths.—On the larval metamorphoses of the *Phoronis sabatieri*, by M. Louis Roule.—Description of a new genus of simple Ascidia, Gamaster Dakarenis, by M. A.

Pizon. This genus resembles generally the *Eugyra*, from which however it is clearly differentiated by the structure and position of the genital organs.—On the existence and development of the eggs of the sardine in the waters of Concarneau, by MM. Fabre-Domergue and Biétrix.—The latent life of grain, by M. V. Jodin.—Remarks on the preceding communication, by M. Armand Gautier.—Analysis of one of the meteoric stones that fell at Madrid, February 10, 1896, by M. S. B. Mirat. The meteorite consisted practically of the silicate of magnesium and iron, containing also estimable quantities of aluminium, nickel, and calcium.—Artificial reproduction of malachite by a new method, by M. A. de Schulten.—On the liassic domes of the Zaghouan and of Bou-Kournin, by MM. E. Ficheur and E. Haug.—The part played by the hind limbs in the motion of the horse, by M. Le Hello.—On a relation between muscular energy and sensibility, and on the laws of variation of this energy with respect to time, by M. C. Henry.—Photographs by the X-rays of a bullet in the brain, by MM. E. Brissaud and Londe.

NEW SOUTH WALES.

Linnean Society, April 29.—Mr. Henry Deane, President, in the chair.—Theoretical explanations of the distribution of southern faunas, by Captain F. W. Hutton, F.R.S. After reviewing the various theories which have been offered to explain the difficult and intricate problem of the distribution of southern faunas, the author pointed out that the supposition that the ancestors of certain groups migrated from the northern into the southern hemisphere by the present continents, and have since then become extinct in the north, explained a good deal, but failed to give a full and satisfactory explanation of the whole of the facts. Moreover the members of the fauna unaccounted for are old forms, and consequently the means of communication which served them must long ago have been destroyed. To the author a fatal objection to the theory of migration by way of an Antarctic continent is offered by the following consideration. Aplacental mammals—both Multituberculata and Polyprotodontia—existed in Europe and North America in the Triassic and Jurassic periods, and these Polyprotodontia were, no doubt, the ancestors of the living Polyprotodontia of Australia. In the Eocene strata of Patagonia remains of a large number of Polyprotodontia have been found which are far more closely related to the Polyprotodontia of Australia than to the Mesozoic forms of Europe and North America; consequently a direct land communication must have existed between these two southern countries. Now there is strong geological and palæontological evidence that no land ridge existed between North and South America during the Mesozoic and early Cainozoic eras; consequently it must be assumed that the southern forms migrated through the Malay Archipelago; and, if they went to Patagonia by means of an Antarctic continent, they must have passed through Australia. But mingled with the Eocene marsupials of Patagonia there are a number of Eutheria of typically South American character without any northern forms of *Artiodactyla*, *Carnivora*, or *Insectivora*; and it is hardly possible that these should have passed through Australia without leaving any record behind. The theory of the former existence of a South Pacific Mesozoic continent, first suggested by Huxley, seemed to be the only theory left. It not only explains the origin of the Australian and South American marsupials, but also the almost simultaneous appearance of different Eutherian mammals in North and South America. It must be supposed that this continent threw off first New Zealand, then Australia, then Chili, and finally disappeared under the waves. At a later date, New Zealand must have formed part of a large island joined to New Caledonia, but not to Australia. The objections to this theory are geological rather than biological, involving the doctrine of the persistence of continental and oceanic areas upon which geologists are not agreed; and such objections are equally applicable to the theory of an Antarctic continent.—Report on a Bone Breccia deposit near the Wombeyan Caves, New South Wales: with descriptions of some new species of marsupials, by Dr. R. Broom. A detailed examination of this deposit from which *Burramys parvus* and *Palæopetaurus elegans* have already been described by the writer, adds considerably to our knowledge of the smaller marsupial fauna of the later Tertiary period. Of existing forms there have been found *Petaurus breviceps*, *Dromicia nana*, *Phascologale flavipes*, *P. penicillata*, and some detached teeth referred to *Thylacinus cynocephalus*. Besides these are found a presumably new species of *Macropus* for which the name of *M. wombeyensis* is proposed, a new species of *Pseudochirus* (*P. antiquus*), a new species of *Perameles* (*P. wombeyensis*), and an extinct variety of the existing *Potorous tridactylus*. A few bones of a large *Echidna* are referred to *E. oweni*. There are also innumerable remains of bush rats (*Mus* sp.), together with a few bones of small birds and lizards.—The entomology of Australian grass trees (*Xanthorrhœa*), by W. W. Froggatt. The life-histories or habits of a number of insects which either breed in the stems of the grass tree or feed upon its foliage were described.—On the *Galaxias* from Mount Kosciusko, by J. D. Ogilby. After reviewing its history and describing the species (*G. findlayi*, Mcl.) from a fine series, obtained from streams on both watersheds of the Australian Alps, the author gave an account of the curious distribution of this fresh-water family of fishes, with special reference to its Antarctic origin, and concluded with a list of the known forms, holding that far too many species had been made by naturalists who relied too much on contour and coloration, both of which characters are most inconstant.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—An Elementary Treatise on the Integral Calculus: Dr. B. Williamson, 7th edition (Longmans).—Im Australischen Busch und an den Küsten des Korallenmeeres: Prof. R. Semon (Leipzig, Engelmann).—A Manual of Mending and Repairing: C. G. Leland (Chatto).—Macmillan's Geography Readers, Book VI. (Macmillan).—Arithmetic for Promotion, Scheme B.: Lock and Macdonald, 4 Parts (Macmillan).

PAMPHLETS.—A New Treatment of the so-called Incurably Deaf People: Dr. J. J. Hovent (Bruxelles, Lebègue).—Representation in Virginia (Baltimore).—St. Paul's School and the Charity Commissioners: Colonel Clementi (Bell).

SERIALS.—Science Progress, June (Scientific Press).—Geographical Journal, June (Stanford).—Botanische Jahrbücher, &c., Zweiundzwanzigster Band, 2 Heft (Leipzig, Engelmann).—Proceedings of the American Philosophical Society, December (Philadelphia).—Physical Review, Vol. 3, No. 6 (Macmillan).—Proceedings of the Royal Society of Victoria, Vol. 8, new series (Williams).—American Journal of Science, June (New Haven).—Engineering Magazine, June (Tucker).—Bulletin of the American Mathematical Society, May (New York, Macmillan).—Westminster Review, June (Warne).—Leisure Hour, June (56 Paternoster Row).—Proceedings of the Physical Society of London, Vol. xiv. Part 6 (Taylor).—Rapport Annuel sur l'Etat de l'Observatoire de Paris, 1895: M. F. Tisserand (Paris).—American Naturalist, June (Philadelphia).—Journal of the Franklin Institute, June (Philadelphia).

CONTENTS.

THURSDAY, JUNE 25, 1896.

CLOSELY ALLIED "SPECIES."

Monographie der Gattung Euphrasia. Von Dr. R. von Wettstein. 4to. Pp. 316. With 14 plates and 4 maps. (Leipzig: Wilhelm Engelmann, 1896.)

EUPHRASIA is one of those genera exhibiting a very limited range of variation, as compared with *Ranunculus*, *Senecio*, *Solanum* or *Euphorbia*; yet abounding in closely allied forms, concerning the rank of which there is great diversity of opinion amongst botanists. Bentham and Hooker in their various works, including a monograph of the genus by the former, estimate the number of species at about a score, whilst the author of the monograph under consideration defines nearly a hundred. Whatever our opinion may be respecting the utility of this extreme subdivision, most of us will agree that a profound study of the manner and extent of this limited kind of variation should furnish some interesting results. Moreover the genus *Euphrasia* is admirably suited for this purpose, because it is possible to have the entire plant in all cases.

First, with regard to the utility or convenience of naming such closely allied forms, whether they be ranked as species or varieties. Names are given, of course, as a means to an end. The botanist names his species and the florist his varieties, and there seems no reason why a specialist should not carry his naming as far as his studies lead him. Few may care to attempt to follow him, and he may be impossible to follow, as some of the hieraciologists of the present day are; but no harm is done, no confusion arises. The generally-accepted application of the name *Euphrasia officinalis* is not destroyed by giving names to the various forms it presents. But when the author claims for them that they are "good species," because they are constant under cultivation, or because they have a wide range, or for some other reason we reach a debatable point.

Euphrasia is a genus of small, slender annual and perennial herbs, parasitic on the roots of other plants, chiefly on grasses and sedges, according to Wettstein and other investigators. Bentham divided the species into three sections, which are practically adopted by Wettstein; and these sections inhabit as many widely separated geographical areas. First there is the *officinalis* group, which is confined to the northern hemisphere. Then there is a group restricted to Australia and New Zealand, with the exception of a single species inhabiting Mount Kinabalu, in North Borneo. The third group inhabits western South America, from about 15° S. lat. to Cape Horn. The Bornean species, and another in the Andes of Peru, are the only ones found within the tropics. The total absence of the genus in Africa, the African islands, the mountains of South India and Malaya, with the one exception noted, is a remarkable fact, especially as the genus reaches the north shores of the Mediterranean from end to end, and the Azores, where there is a very distinct endemic species. In eastern North America the genus extends as far south as the north shores of the lakes; it is absent from the centre, and its southern limit in the west is the northern part of the Rocky Mountains. But by some mischance Dr. Wettstein has located the White Mountains of New Hampshire somewhere in Utah! At least he gives the White Mountains as the locality of the species in the text, whilst on his map it occupies the isolated position indicated.

The geography is weak in other places, more especially in the arrangement of the localities in Central Asia. Indeed the author has by no means made the most of the geographical aspects of the question. He has one map showing the general distribution of the genus, and three others showing the areas of the principal northern species; but the explanatory text is altogether insufficient, considering the small scale of the maps. It is interesting to note that many of these critical species have a wide area, and few are really very local. *E. stricta* has two pages of synonyms and seven pages of localities, from which it would appear that the author has examined some thousands of specimens. *E. rostkoviana*, a very common and widely-spread species in Europe, has also been found in Canada, whither it may possibly have been taken with grass-seed.

Without sharing the author's views on species, concerning which he is very confident, I would strongly recommend his monograph for study. It has been considered worthy of a De Candollean prize.

W. BOTTING HEMSLEY.

THE AUTOBIOGRAPHY OF PROFESSOR W. C. WILLIAMSON.

The Reminiscences of a Yorkshire Naturalist. By the late William Crawford Williamson, LL.D., F.R.S. Edited by his Wife. Pp. xii + 228. (London: George Redway, 1896.)

IN the "Reminiscences of a Yorkshire Naturalist," Prof. Williamson has left an autobiographical sketch, containing much that is of general scientific interest, and many delightful records of his own personal history. This simple story of a student's life, which Mrs. Williamson has done wisely to publish in its original form, takes us back to a period which, to the present generation of students, suggests the dawn of modern science.

These reminiscences link, in a picturesque and striking manner, the past with the present. In speaking of his boyhood spent by the Scarborough cliffs, Williamson describes how he examined, with a pocket-lens, the little cups at the tips of *Polytrichum* stems, and wondered whether the reproductive organs, which so many botanists were in search of, were enclosed within these cups. His graphic description of the Father of English geology, recalls the infancy of geological science. As a boy he remembered William Smith, with "the drab knee-breeches and grey worsted stockings, the deep waistcoat with its pockets well furnished with snuff, . . . and the dark coat with its rounded outline and somewhat quakerish cut." It was during his apprenticeship to Mr. Weddell, a Scarborough medical practitioner, that he first contributed to palæo-botanical literature; many of the plates in Lindley and Hutton's "Fossil Flora" were drawn by the young

naturalist at one end of his master's kitchen table, "whilst the housekeeper was occupied at the other end with the several processes of providing the day's dinner." At the age of seventeen, Williamson wrote an important memoir on a tumulus near Gristhorpe Bay, which called forth a letter from Prof. Buckland praising the article, and prophesying that the author's name would "figure in the annals of British science." Passing from these early days of youthful enthusiasm and the pursuit of natural history in all its branches, and over many years of activity in zoological and medical work, we come to the latter part of Williamson's career. The memoirs on the Coal-measure plants, published in the *Philosophical Transactions*, between the years 1870 and 1893, furnish a splendid record of original work, which will always rank among the most important additions to botanical knowledge during the later decades of the present century. It would be difficult to find a more striking illustration of the continuance of vigorous industry, and the power of adaptability to modern methods, than is afforded by the palæobotanical writings of a man whose early days were spent before modern science began.

Did space permit, one might quote numerous passages in which recollections are given of the "sober-minded quaker John Dalton," and of the first meeting with Joule, "a young and extremely unassuming man." The autobiography gives us an epitome of the advance of scientific thought during the present century, with the added charm and freshness of a personal history of the almost ideal scientific career of a genuine naturalist. "Writing these reminiscences of his life's work, was one of the pleasures of Dr. Williamson's later years"; and we are grateful to Mrs. Williamson for giving us the opportunity of sharing the enjoyment of so fascinating a retrospect.

It is a matter of regret that Dr. Williamson's name does not appear in the title of the book; it would have afforded a better index to the interesting contents.

A. C. S.

OUR BOOK SHELF.

Die Protrophie, eine neue lebensgemeinschaft in ihren auffälligsten erscheinungen. Von Arthur Minks. (Berlin: Friedländer and Sohn, 1896.)

DR. MINKS is already well known as the author of several treatises on the biology and morphology of Lichens, in each of which the ideas set forth are quite original, and at the same time directly opposed to modern views regarding the structure presented by this group of plants. The present contribution must be considered as part iii. of "Contributions to a knowledge of the structure and life of Lichens," of which the previous parts appeared in an Austrian scientific publication (*K. K. zool.-bot. Gesell. zu Wien*). The present, preceded by a digest of the leading ideas embodied (*Oester. Bot. Zeitschr.*, 1896, p. 50) appears as an independent publication. The previo'us parts contain, amongst other new views, the ptatement that many species considered as valid by slichenologists, are the outcome of parasitism between two or more originally distinct species, the product being a pseudo-species, differing in structure and general appearance from the species concerned in its production. In the book under consideration, the contents of which could not be understood without a knowledge of the author's previous views and theories, we are introduced to a second method which, as before, results in the wholesale production of what may be termed pseudo-species, due to the intermingling and gradual changing of the layers of the thallus. This change is said to be due to "Protrophie"; a statement which must be accepted in good faith. The definition given would be next to meaningless in English, hence it is offered in the original language.

"Ich erachte es für statthaft, die Unselbstständigkeit, die nur den Anfang des Lebens betrifft, daher auch nur für diese Zeit der schützenden und unterstützenden Flechte zur Einleitung und Sicherung von dessen hauptsächlicher Dauer in aller Selbstständigkeit bedarf, unter Protrophie zu begreifen und die dazu bestimmten Flechten als Lichenes protrophici zu bezeichnen."

The most remarkable circumstance in connection with these supposed discoveries is the fact that the author was enabled to utilise herbarium specimens for his researches, and had not to resort to the more laborious and exact method of pure cultures. G. MASSEE.

Mathematical Papers read at the International Mathematical Congress held in connection with the World's Columbian Exposition, Chicago, 1893. (New York: Macmillan and Co.)

THIS book, which is an excellent specimen of mathematical printing, constitutes vol. i. of "Papers published by the American Mathematical Society." The 400 pages contain thirty-nine papers. German and American mathematicians are the largest contributors; there are a few pages from France, Italy, Austria and Russia also, but the mathematicians of England are not represented. Papers of great interest are given by Dr. Schönflies, "Gruppentheorie und Krystallographie"; by Dr. Heinrich Burkhardt, "Ueber einige mathematische Resultate neuerer astronomischer Unsuchungen, insbesondere über irreguläre Integrale linearer Differentialgleichungen"; by M. Maurice d'Ocagne, "Nomographie: sur les équations représentables par trois systèmes rectilignes de points isoplèthes"; by E. H. Moore, "A doubly infinite system of simple groups." Prof. Felix Klein, of Göttingen, whose work at the Congress has been already published in a separate volume, is only represented here by two short communications, one on "The Present State of Mathematics," the other on "The Development of the Theory of Groups during the last Twenty Years." They are of the nature of lightning sketches by a master hand.

The book is an evidence of the formation, gradual but sure, of an American school of mathematicians which, at first mainly inspired by Cayley and Sylvester, appears now to be coming under the influence, principally, of modern German methods.

Modern Optical Instruments and their Construction. By Henry Orford. Pp. 100. (London: Whittaker and Co., 1896.)

WHEN a book bearing the title "Modern Optical Instruments" is found to contain nothing about the telescope, merely a reference to the microscope, and but two pages on the spectroscope, it is the duty of a reviewer to declare that the volume is not what it pretends to be. The contents belong almost entirely to ophthalmoscopy; that is to say, to the determination of optical defects by means of the opthalmoscope, and the amelioration of them by means of spectacles. There are, in addition, brief chapters on stereoscopic projection and the optical lantern. As a short work on these matters, the book is not altogether bad (though the illustrations are very coarse), and opticians may find interest in parts of it. But to say the book is "a description of a few of what may safely be termed the more popular optical instruments in use," and to give it the title it has, is to court adverse criticism.

The book as published contains two-thirds text and one-third advertisement.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Cattle Plague in Africa.

THE following extract from a report addressed by Captain F. Lugard, C.B., managing director and leader of the expedition sent out by the British West Charterland to work its mining rights in Ngamiland, referring, as it does, to the outbreak of cattle disease which now paralyses transport throughout South Africa, may be of interest to the readers of NATURE.

There can now be little doubt that the present epidemic, known under the common name of "rinderpest," is the same as that with which we have been familiar in Central Africa for the past six years, and for the inroad of which into South Africa we ought long ago to have been prepared.

Commencing, so far as we know, in Somaliland in 1889, where the disease killed off a large part of the cattle, it passed through Masailand in the autumn of 1890. It was there that Captain Lugard, then an officer of the Imperial British East Africa Company, first came in contact with it. In 1891 he again found it sweeping off the cattle in the countries to the north and west of Uganda, of which province he was the Administrator. In 1892 it invaded North Nyasaland, and the Government were then duly warned of the double danger to be apprehended from the free export of hides of diseased animals, thousands of which were taken to America and to Europe, and through the advance of the epidemic into South Africa, should it cross the Zambesi and enter Bechuanaland.

The great peculiarity of the present disease is that it attacks not only domestic cattle, but also certain classes of wild animals, chiefly the buffalo, giraffe, warthog, the eland, and several other species of antelope. The elephant, the rhinoceros, and most of the smaller antelopes seem not to be affected, but in countries where it has appeared the destruction of cattle has been general.

The only accurate account of its previous ravages with which I am acquainted is to be found in Captain Lugard's work on "The Rise of our East African Empire," to which I would refer those who may wish to follow the course of the present epidemic from Somaliland South to Nyasaland.

Captain Lugard, writing from Gaberones, in Bechuanaland, May 13, says: "The results of the 'rinderpest' are here terribly *en évidence*. Near villages, literally hundreds and thousands of dead carcases lie about; they are found under almost every bush, and the stench is indescribable. I noticed that these carcases are being skinned by the natives, which means that the hides will be smuggled into the colony, and perhaps exported. I pointed this out yesterday to the magistrate here, and suggested that parties of police should burn the bodies in field cinerators, as fuel is abundant. He told me traders were buying up the hides, and he would recommend their confiscation and destruction by Government." He adds further on: "The magistrate told me that between here (Gaberones) and Buluwayo there are at least 4000 wagons stranded along the road (mostly loaded), of which the ox teams are dead. A famine threatens the country, for the ox is not only the food, but the money of the natives, with which they buy grain, &c. It is also their agricultural agent, for they no longer use the hoe; hence agriculture is at a standstill. The sole counterbalancing good is that it will compel the natives to work on the railway, which will now become a 'famine relief' work."

As little is known of the nature of the disease—some who have seen it in Central Africa classing it as a form of anthrax, others as a sort of pleuropneumonia—I annex an account of the chief symptoms as seen in the present epidemic in South Africa.

As regards the export of hides of diseased animals, to which Captain Lugard refers, which has gone on freely, and, to a large extent, from the Somali ports and from Zanzibar, I may remark that all hides before shipment are there dipped in a solution of arsenic and soda, which may, to a considerable extent, destroy any poisonous germs they contain.

The whole matter is now likely to be thoroughly worked out, but it cannot but be regretted that an inquiry was not instituted several years ago, when so many favourable opportunities of doing so were presented both on the Zanzibar coast and in Nyasaland.

JOHN KIRK.

Sevenoaks, June 10.

"*Zambesi Cattle Fever or Rinderpest.*

"This is a feverish disease of typical rapid course, which spreads by contagion and chiefly attacks cattle. Sheep, goats, and game are less liable; human beings, horses, mules, and donkeys do not get it. A healthy animal which has come into contact with a sick one usually shows the first symptoms of the disease seven days after; occasionally the period is considerably longer.

"General symptoms are fever, weariness, uneasiness, rough coat, failing appetite, increase of pulse and breathing, convulsive trembling of skin, rapid emaciation, and decline of strength.

"Special symptoms: One of the first and most constant is a frequent short cough, and thin slimy, afterwards mattery, discharge from the inflamed and swollen mucous membranes of the nose, eyes, and even mouth On the third (rarely so soon as the second) day diarrhœa sets in. The colour of the fæces depends upon the character and degree of the inflammation of the bowels. At the beginning they are still green, but quickly become discoloured. Some animals evacuate grey-brown, some a gelatine-like yellowish brown, and some clay-like fœtid excrement; the dark colour is due to the presence of blood. From the fourth or fifth day the fæces flow off involuntarily, and the anus appears red and swollen. Sometimes small ulcers and sores are visible on the mucous membrane of the lips, gums, and cheeks, and on those parts of the skin which can be licked.

"Diseased animals rarely succumb, earlier or later, than from the fourth to the seventh day after the first symptoms have become manifest.

"Experience has always shown that medical treatment is of no avail, but merely tends to spread the malady. It is therefore wisest and cheapest to destroy all animals affected at the earliest possible moment, and all carcases, unskinned and complete, should be burnt carefully or deeply buried.

"The disease does not originate through influences, such as cold and fog, dew or rain, but is solely due to a vegetable parasite, which is able to spread easily and rapidly.

(Signed) "OTTO HENNING,
"Government Veterinary Surgeon."

"The foregoing is published for general information. It is hoped that all will realise this great danger and the serious losses which the spread of the pest would produce, and that all will assist the authorities in extirpating it.

(Signed) "F. J. NEWTON,
"Resident Commissioner.

"Mafeking, March 16."

The Electrical Resistance of Alloys.

IN reference to Lord Rayleigh's very interesting note in your issue of June 18, we have, for several months, had preliminary experiments in progress, with the object of educing practical proof of the effects of thermo-electric currents upon the conductivity of alloys; but, owing to the stress of routine work in our respective departments, the research was not sufficiently advanced for publication. We had hoped, however, to be able to read a short note immediately after the long vacation.

About two years ago, one of us, who has been engaged in observing the microscopic structure of alloys, was first led to the conviction that the peculiar formation (so often met with) of metallic crystals enmeshed in a network of other metallic material must inevitably cause the production of thermo-electric currents when a current was passed through the alloy-mass. This, he believed, might account for the disproportionate effect of traces of impurities upon the conductivity of pure metals, and for the production of a curve (with percentages of impurity and electrical resistance as coordinates) which, steep at first, tended to become flatter as the percentage of impurity was increased. Prof. Dewar's experiments on the conductivity of pure metals, and of alloys at low temperatures, appeared to give additional proof of the correctness of this surmise, as Lord Rayleigh has pointed out. The pure metals, being perfectly homogeneous, may have no resistance at the absolute zero of temperature; but if other substances be added, so that there is produced the complex structure which the microscope shows the

mixture to possess, there would obviously be interference produced by the thermo-electric currents set up owing to the juxtaposition of these masses of unlike metals. It would be particularly interesting to observe whether pure entectic alloys or chemical compounds of metals, which alone appear to form really homogeneous masses of mixed metals, would behave like pure metals, or like other alloys in regard to conductivity at low temperatures.

In order to detect the presence of opposing E.M.F.s, we first tried the experiment of passing a fairly intense current through a bar of alloy, breaking contact by means of a simple switch, and immediately making connection with a galvanometer, the interval of time elapsing between the reversal of connections being but a small fraction of a second. We have hitherto, however, failed to obtain any indication in this manner, a fact which we ascribe to the rapidity with which the temperature of the mass is equalised, owing to the minute size of its constituent particles, and to the appreciable time that must elapse between the break of the current and the contact with the galvanometer. Even when the time was reduced to 1/100th of a second or less by the use of a Morse key, and when the process was repeated five times a second, no consistent indication of a residual E.M.F. could be detected with a D'Arsonval galvanometer giving a deflection of 0·5 mm. per micro-volt. The ordinary thermoelectric effects had of course to be eliminated, and were very troublesome.

The next experiment was to balance the resistance of two pieces of wire of equal diameter—one of copper, the other of alloy—against each other, using equal ratio arms on a Wheatstone bridge, and then by means of a secohmmeter to try if the resistance of the alloy diminished when the current was rapidly reversed. In all cases there was found to be a distinct reduction of the resistance of the alloy relatively to the copper, the above-mentioned galvanometer giving deflections of from 10 to 15 mm., with 60 reversals per second. In one case the alloy was copper = 75 per cent. : gold = 25 per cent., the wire being 0·7 mm. in diameter and 820 mm. long, whilst the copper wire was 0·7 mm. in diameter and 4100 mm. long ; the current used was about 1·5 amp., and the resistance of each wire was about 0·18 ohms. A deflection of 15 mm. on the galvanometer scale, corresponding to 30 micro-volts, would be caused by an unbalanced E.M.F. in one of the wire = 105 micro-volts, or, say, 1/2600th of the total E.M.F.

The time actually occupied in the reversal of the current was estimated as varying between 1/500th and 1/1000th of a second, which was the time available for equalisation of temperature before the current was started in the opposite direction. Any residual E.M.F. would then *assist* the current at "make," and so reduce the apparent resistance. In any case, at the first instant of starting the current, the opposing E.M.F. would be absent, but the time required for its appearance would be very small compared with the time between reversals (1/60th of a second). Increased effect should therefore be sought by increasing the number of reversals per second rather than by shortening the time between stopping and re-starting the current.

Care was, of course, taken to ensure equal capacities and inductances in each pair of arms of the bridge ; and an experiment was made to see if the observed effect was due to the current in the copper wire becoming concentrated near the surface. A copper wire 1000 mm. long and 0·35 mm. in diameter was balanced against another copper wire 4000 mm. long and 0·7 mm. in diameter ; but no variation of resistance was observed. At this point the investigation was allowed to rest, pending the construction of special apparatus and the arrival of the summer vacation.

WALTER G. MCMILLAN.
ROBERT H. HOUSMAN.

Departments of Metallurgy and of Physics,
Mason College, Birmingham, June 22.

Are Röntgen Rays Polarised?

MR. L. CASELLA has made for me a Crookes' tube having as the anode a platinum window sealed into the end of the tube opposite the kathode, which is the ordinary aluminium disc. Owing to the glass sealing, only a small portion of the platinum, about 3 mm. in diameter, is free to act. The light from all but this portion was screened off by thick glass discs and a brass disc, these having each an aperture in the centre. The result, with the fluorescent screen, was at first poor, because the vacuum was too low ; but as that got higher it improved, and I was able to electrograph a part of the hand, by the rays given off by this small platinum window, in 15 seconds, the plate being 2½" from the window. An ordinary focus tube takes 30 seconds to produce the same effect under similar conditions, but gives better definition. With the platinum window tube, though the bones are defined on the fluorescent screen, there seems to be too much white light, and the difference between bones and flesh is less marked. The tilted platinum of a focus tube, apparently, reflects most of the kathode rays, but transmits some. Compare the behaviour of the platinum in both tubes with the action of light on glass. With both glass and platinum, part of the rays are transmitted and part reflected, the proportion varying with the angle of incidence ; but, with both, those rays which are perpendicular are apparently transmitted. If the glass be tilted at the proper angle, the reflected rays and a small part of the transmitted rays are polarised. Suppose the plate of glass in the position of the platinum window, and the source of light a luminous point within the tube ; although most of the transmitted light would be radiated direct from the luminous point, part would be rays which had been polarised by reflection from the walls of the tube. The analogy would still hold good, for we know that, as far as X-rays are concerned, glass behaves very similarly to platinum, for these rays are under suitable conditions given off by both.

These considerations and the appearance of microscopic preparations containing bone undecalcified when examined by low powers and ordinary light under Nicol prisms, lead me to hazard the suggestion that a bare possibility exists of X-rays being polarised kathode rays. Were this so, the two kinds of X-ray described by several observers would be explained, and we should also understand why those who have tried to polarise these X-rays should have failed, the rays being already polarised. If this view is correct, extinction of the X-rays should be caused by reflection from a second platinum surface at the proper angle. Whether this would succeed at atmospheric pressure, I know not ; the experiment should be tried in vacuo, and a tube constructed specially for the purpose. The window tube has, at all events, proved that a quantity of kathode rays, with some X-rays, may be transmitted through moderately thin platinum under these conditions.

J. WILLIAM GIFFORD.

Chard, June 9.

A Curious Bird's Nest.

A CURIOUS bird's nest, or rather its adjuncts, has lately been presented to the Warwick Museum. It was found in a curved iron pipe intended to deliver water from a well at the baths, and appears not to have been used for some time. The entire length of the pipe was four feet, and the diameter five inches. The bird had built its nest in the centre, and had not only surrounded it with moss and other materials, but had extended them for some length on each side, the total amounting to two feet two inches. The singular thing is that the bird should have taken so much trouble to do this, and it really might seem as if, like the bower birds, it had done it in sport ; for it was not necessary (though the sharp little bird may have thought so) for the preservation of the nest to extend it so far on each side with moss, feathers, and other things. The eight small eggs in the nest appear to have belonged to the blue titmouse.

June 22. P. B. BRODIE.

"Hydrodictyon reticulatum."

IT may interest readers of NATURE who collect fresh-water Algæ, to know how easy of cultivation is this beautiful species It occurs frequently, though by no means every year, in one of the tanks in the Royal Gardens, Kew. Last summer, about this time, I gathered it there in considerable quantities. After preparing specimens for demonstration, I placed the remainder in a glass dish, where it remained in my study, entirely neglected, except for an occasional renewal of the water, until a week or two ago, when I found it still in beautiful condition, with both large and small nets. It is to be found again this year in its original habitat, with nets of an unusually large, almost gigantic, size.

ALFRED W. BENNETT.

London, June 20.

"The Old Light and the New."

YOUR reviewer expressed an opinion, and makes two statements, and the six lines comprise his review of my book. The opinion, being on a matter of business, may be right or may be wrong. The statements are supposed to relate to fact; but they must be the outcome of hasty reading, for the "large portion of the book, dealing with theories of the natural colours of bodies," cannot surely be spoken of as "padding" in a work whose sub-title is "The Chemistry of Colour," and one of whose objects is to show that the Röntgen rays and matter yield "invisible" colour which conforms to the same laws as "visible" colour. Nor do I think it correct to call information on the X-rays "sketchy" because it happens to be concise.

WILLIAM ACKROYD.

IN my brief criticism of Mr. Ackroyd's book, I did not intend to suggest that the *whole* of the section on natural colours was "padding." My meaning would, perhaps, have been clearer had I written, "a large portion of that part of the book which deals with theories of the natural colour of bodies is nothing more than padding." The forty pages which comprise the chapter on "The Chemistry of Colour," contain the substance of a lecture delivered before the Society of Dyers and Colourists, and is so full of tabular details, while the remainder of the book is of a very elementary character, that it certainly gives the impression of having been included more to increase the bulk than on account of suitability.

YOUR REVIEWER.

"The Reminiscences of a Yorkshire Naturalist."

THE brevity of the reference, on page 205 of "The Reminiscences of a Yorkshire Naturalist," by Dr. W. C. Williamson, to the memoir in the *Annales des Sciences Naturelles*, may give rise to misconception. Prof. Hartog's share in this work was by no means that of a mere translator, although his exceptional ability as a French scholar was of essential service. His collaboration extended to the substance as well as the form of the memoir, and he was always fully recognised by Dr. Williamson as its joint author.

A. C. WILLIAMSON.

Post-Graduate Study in London.

COULD you inform a graduate in science of London University whether there is any place in London where he could attend post-graduate and research courses of study in botany? He is engaged as science master in a large public day-school, but is anxious to study botany in his spare time. Any information will greatly oblige.

"PUTHOS."

June 14.

LORD KELVIN'S JUBILEE.

OUR summary in last week's issue of the proceedings at Lord Kelvin's jubilee celebration gives only a faint idea of the completeness and success with which every part of the festival was carried out, or of the enthusiasm which characterised what was the world's tribute of admiration to the achievements and personal qualities of a truly great man. The list of delegates and visitors which we give on pp. 174–5 will convey some idea of the unanimity with which science and learning throughout the world have done honour to one who, besides advancing pure science in a remarkable degree by his own abstract researches, has not disdained to apply his great knowledge of scientific principles to the construction of apparatus and appliances which have promoted peace and good will among men and aided commerce by placing continents in telegraphic communication, by improving and facilitating navigation, and last but not least, diminished the perils to which those who sail the seas are exposed. A great physical mathematician, a physicist to whom physical principles are intuitive, an engineer whom engineers have united to honour as one of the greatest of themselves, Lord Kelvin has many scientific interests, and there is no department of science which is not the larger and richer for his work.

The opening meeting of the celebration was the conversazione on Monday evening at the University. The guests were received by the Senatus Academicus, and the members of the Corporation of the City of Glasgow headed by Lord Provost Sir James Bell, in the Randolph Hall, which forms a "Fore Hall" or vestibule for the magnificent Bute Hall in which the high ceremonies of the University are held. In the Bute Hall, a little beyond the entrance and to the left, chairs were set for Lord and Lady Kelvin, who stood receiving the individual congratulations of the multitude of distinguished visitors. After thus paying their respects to the hero of the occasion, the guests passed on to meet one another, to renew acquaintanceships, to look at the treasures of the museum, and to inspect the splendid collection of instruments, diplomas, and medals which had been arranged to illustrate Lord Kelvin's researches and inventions, and the honours he has received. In this exhibition were many things of great interest, and we will not attempt even their enumeration. To give an adequate account of the instruments alone would require several numbers of NATURE, while the diplomas, mostly in Latin and of extraordinary distinction, represented the honour in which Lord Kelvin is held by the learned societies at home and abroad. Beginning with the certificate of the Bishop of Ely approving the appointment of William Thomson, B.A., as a Fellow of Peterhouse, they ended with the credentials of Sir William Thomson or Lord Kelvin's election as member of every one of the most distinguished scientific societies of the world, and included the letters of the Perpetual Secretary announcing, first, Lord Kelvin's election as Corresponding Member, next, as Foreign Associate of the Institute of France, and the announcement of his appointment as *Grand Officier* of the Legion of Honour.

The part played by the telegraph in the conversazione formed an exceedingly interesting part of the proceedings. The chief Cable Companies—the Anglo-American, the Commercial, the Eastern, and the Brazilian Submarine—sent congratulations, and instruments were arranged in the Library Hall whereby messages could be received from all parts of the world during the soirée. The Anglo-American Company's message may here be quoted, as it gives in a few words that credit for rendering by his instruments submarine telegraphy practically possible, which is Lord Kelvin's due, and that by a large portion of the commercial public that carries on business by means of cable communication is either unknown or apparently forgotten.

In 1858 Professor William Thomson took out his first patent for a system of working long cables, and for instruments (including the mirror-galvanometer) calculated for producing a high rate of transmission. In the Atlantic expedition of 1858 Professor William Thomson, at that time one of the directors of the Atlantic Telegraph Co., at the request of his brother directors, took upon himself the duties of electrician on board H.M.S. *Agamemnon*, which had been placed at the disposal of the company for the laying of the first Atlantic cable; and when the cable had been laid, it was Professor William Thomson's inventions and genius which caused a sufficient number of messages to be transmitted to demonstrate the practicability of Atlantic telegraphy, thus contributing most materially to the present success.

Our readers will remember that the theoretical solution of the problem of telegraph signalling by Lord Kelvin consisted in showing that the "retardation" of a signal increases in direct proportion to the square of the length of the cable supposed of a given pattern; and that therefore it was only possible by using receiving instruments far surpassing in delicacy the most sensitive of land instruments that intelligible signals could be obtained at all. There can be no manner of doubt that it was the tremendous battery power used to actuate the primitive receiving instruments that ruined the cable first laid, and brought temporary disaster to the promoters. The mirror-galvanometer with its needle and mirror of a grain or two hung by a single fibre of silk, and its long mass-

less index of a ray of light, first overcame the difficulty and reduced the battery power required to something like a fiftieth or a hundredth part of that originally employed. Then came the beautiful siphon-recorder with its pen of lightest capillary tubing, through which the ink was forced by electrical action, so that it wrote its message on a ribbon of paper without actually touching the paper-surface, thus avoiding in the most ingeniously simple manner what for long-cable signalling would have been most detrimental, the friction of the glass on the ribbon. The recorder-siphon once deflected registered successive signals in the same direction by small ripples drawn on the moving paper as from a new zero, and thus the reduction to zero between two of these signals of the current deflecting the coil, was rendered unnecessary. The shifting zero of the siphon-recorder was made still more definite in whatever position it took up by means of curb-sending, which brought out clearly the individual ripples of the last three signals of the letter *b*, the four successive signals in the same direction which form the letter *h*, and so on.

Returning, however, to the conversazione and the part played by the telegraphic instruments, we have first to mention the message of congratulation which was sent by the Jubilee Committee to Lord Kelvin, present in the same room, round a circuit as long as about three-quarters of the earth's circumference. The Anglo-American Company sent the message to Heart's Content, thence to New York, thence round by Chicago and San Francisco back to New York, thence again to Heart's Content and Glasgow. The message was as follows :—

By the Atlantic cable which represents your unrivalled combination of scientific genius and practical skill, the Glasgow Jubilee Committee send you their warmest congratulations.

The interval between sending and receiving was seven and a half minutes, and Lord Kelvin replied :—

The Cable Companies have beaten Ariel by half a minute. Warmest thanks to the Glasgow University Jubilee Committee.

The reply took only four minutes.

From Simla the Viceroy of India telegraphed :—

I offer congratulations and desire to join with the University of Glasgow in celebrating your fifty years of service. We in India, thanks to your labours, constantly feel closer to friends at home.

From the capital of the Orange Free State the following message was received :—

The President of the Orange Free State, in the name of many Free Staters who have either directly or indirectly profited by Lord Kelvin's magnificent services to science, desires to offer his hearty congratulations to Lord Kelvin on the celebration of his professorial jubilee.

Congratulatory telegrams were also received from Earl Grey (Buluwayo), Sir James Sievewright (Cape Colony), the Earl of Glasgow (Wellington, New Zealand), the Postmaster-General of New Zealand, Sir John Robinson (Prime Minister of Natal), the Governor of Hong Kong, Lord Hampden (Sydney), the Universities of Adelaide, Madras, New Zealand, Calcutta, Santiago, the Johns Hopkins University of Baltimore, and Chicago, from the Indian Telegraph Department, the College of Science, Poona, and old students and friends in Japan, and almost all parts of the world.

Lord Kelvin telegraphed his thanks to General Eckert, the President of the Western Union Telegraph Company, New York, in the following terms :—

Pray accept my sincere thanks to yourself and staff for your great kindness and assistance. The messages you have transmitted to me have given very great pleasure to the whole assembly.

The following is a list of the delegates and other distinguished visitors who, besides the Lord Provost, Magistrates, and Town Council, the members of the Senatus Academicus, and the local guests invited, were announced as present at the reception and throughout the celebration :—

REPRESENTATIVES OF UNIVERSITIES, SOCIETIES, INSTITUTIONS, &c.

Austro-Hungary.—Prof. Dr. Izidor Fröhlich, Academy of Sciences, Buda-Pest.

Belgium.—Senator Montefiore Levi, of Brussels.

Denmark.—Prof. C. Christiansen, Royal Danish Society of Science, Copenhagen.

France.—Prof. Aug. Angellier, Academy of Lille; Prof. Pinloche, Academy of Lille; Prof. Lippmann, University of France, Paris; Prof. Henri Moissan, University of France, Paris; Prof. Picard, University of France, Paris; Prof. Bonet Maury, University of Paris; Prof. Eleuthère Mascart, Collège de France, Paris; Prof. Violle, Ecole Normale Supérieure, Paris.

Germany.—Prof. Heinrich du Bois, University of Berlin; Prof. Georg Quincke, University of Heidelberg; Prof. Woldemar Voigt, Royal Society of Science, Göttingen.

Holland.—Dr. Elie van Rijckevorrel, Batavian Society of Experimental Philosophy, Rotterdam.

Italy.—General Annibale Ferrero, Italian Ambassador, London, representing Royal Institute of Science and Letters, Milan; Royal Academy of Science, Letters, and Arts, Modena; Italian Society of Science, Rome. Prof. Peter G. Tait, M.A., D.Sc., Edinburgh, representing University of Rome. Prof. J. J. Thomson, M.A., F.R.S., Cambridge, representing Royal Academy of Turin.

Mexico.—George J. Symons, F.R.S., representing the Antonio Alzate, Scientific Society.

Russia.—Prof. Nicholas Oumov, representing University of Moscow; Imperial Society of Friends of Natural Science, Anthropology, and Ethnography, Moscow; and Imperial Society of Naturalists, Moscow.

Sweden.—Prof. Per Theodor Cleve, University of Upsala.

Switzerland.—Mons. Lucien de Candolle, Société des Arts, Geneva.

United States of America.—Prof. Joseph S. Ames, Ph.D., Johns Hopkins University, Baltimore; James C. Thomas, M.D., Johns Hopkins University, Baltimore; Prof. Cushney, University of Michigan; Prof. Robert M. Wenley, M.A., D.Phil., University of Michigan; Prof. G. F. Barker, M.D., University of Pennsylvania, Philadelphia; Mr. Samuel Dickson, University of Pennsylvania, Philadelphia; Prof. Woodrow Wilson, Princeton University, New Jersey; Prof. Van Amringe, Columbia College, New York; Mr. T. C. Martin, National Electric Light Association, New York; Right Hon. Lord Rayleigh, F.R.S., representing American Academy of Arts and Sciences, Boston; General Wistar, Academy of Natural Sciences, Philadelphia; Dr. J. Cheston Morris, Philosophical Society, Philadelphia.

GREAT BRITAIN AND IRELAND, THE COLONIES, AND INDIA.

Canada.—Sir D. A. Smith, K.C.M.G., LL.D., M'Gill University, Montreal; Principal Peterson, M'Gill University, Montreal; Mr. James Ross, Canadian Society of Civil Engineers, Montreal.

India.—Mr. Justice Jardine, I.C.S., Bombay University; Ghanasham N. Nadkarin, LL.B., Bombay University; Prof. J. H. Gilliland, M.A., Calcutta University.

New South Wales.—Prof. Liversidge, M.A., F.R.S., University of Sydney.

UNITED KINGDOM.

I. Universities.

ENGLAND.

Cambridge University.—Prof. A. R. Forsyth, D.Sc., F.R.S.; Prof. Sir George G. Stokes, LL.D., F.R.S.; Prof. J. J. Thomson, M.A., F.R.S.

Durham University.—Rev. Principal Gurney, D.C.L.; Dr. Merz.

London University.—Prof. Carey Foster, F.R.S.; Sir Henry E. Roscoe, F.R.S.

Manchester—Victoria University.—Prof. Oliver J. Lodge, D.Sc., F.R.S.; Principal A. W. Ward, Litt.D., LL.D.

Oxford University.—Prof. Clifton, F.R.S.; D. B. Monro, M.A.; Provost of Oriel College; Prof. Burdon Sanderson, F.R.S.

IRELAND.

Dublin—Trinity College.—Right Hon. the Earl of Rosse, LL.D., D.C.L., F.R.S. Chancellor of the University of Dublin.

Royal University of Ireland.—Right Rev. Monsignor Molloy, D.D., D.Sc.; William A. M'Keown, M.D.

SCOTLAND.

Aberdeen University.—Prof. Finlay, M.D.; Prof. Niven, F.R.S.; Prof. Pirie.

Edinburgh University.—Prof. A. Crum Brown, F.R.S.; Prof. Sir William Turner, F.R.S.; Prof. Peter G. Tait, M.A., D.Sc.

St. Andrew's University.—Prof. Scott Lang; Prof. Pettigrew, M.D., LL.D., F.R.S.

WALES.

University of Wales.—Prof. Andrew Gray, LL.D. F.R.S.; Principal J. Viriamu Jones, F.R.S., Vice-Chancellor of the University of Wales.

II.—COLLEGES.

ENGLAND.

Birmingham—Mason College.—Principal Heath, D.Sc., F.R.S.

Leeds—Yorkshire College.—Prof. Stroud, D.Sc.

Liverpool—University College.—Prof. M'Cunn, M.A.

London—King's College.—Prof. W. G. Adams, D.Sc., F.R.S.

London—University College.—Prof. Ramsay, F.R.S.

London—City and Guilds Central Technical College.—Prof. W. E. Ayrton, F.R.S.

London—City and Guilds Technical College, Finsbury.—Prof. S. P. Thompson, D.Sc., F.R.S.

Manchester—Owens College.—Prof. Osborne Reynolds, LL.D., F.R.S.

Newcastle-on-Tyne—Durham College of Medicine and Science.—Prof. George H. Philipson, M.D.

IRELAND.

Belfast—Queen's College.—Rev. Thomas Hamilton, D.D., LL.D.; Prof. Purser, LL.D.

Cork—Queen's College.—Prof. W. Bergin, M.A.

Galway—Queen's College.—Sir Thomas Moffett, LL.D.

SCOTLAND.

Dundee.—University College.—Prof. Steggall, M.A.

Glasgow—Faculty of Physicians and Surgeons.—Bruce Goff, M.D., F.F.P.S.

Glasgow and West of Scotland Technical College.—Henry Dyer, D.Sc.

Glasgow School Board.—Sir John N. Cuthbertson, LL.D.; Rev. William Boyd, LL.D.

WALES.

Aberystwith—University College.—R. D. Roberts, M.A., D.Sc.

Bangor—University College.—Prof. Andrew Gray, LL.D., F.R.S.

Cardiff—University College.—Prof. A. C. Elliott, D.Sc.

III.—SOCIETIES, INSTITUTIONS, &c.

ENGLAND.

Royal Society.—Prof. Sir Joseph Lister, M.B., P.R.S.; Sir John Evans, K.C.B., F.R.S.

Cambridge—Philosophical Society.—Prof. J. J. Thomson, F.R.S.

London—Society of Arts.—Sir Frederick Abel, F.R.S.

Astronomical Society.—A. A. Common, LL.D., F.R.S.

British Association for Advancement of Science.—Prof. A. W. Rücker, F.R.S.

Chemical Society.—Prof. John M. Thomson.

Institution of Civil Engineers.—Sir Benjamin Baker, F.R.S., K.C.M.G.

Society of Engineers.—Henry O'Connor.

Institution of Electrical Engineers.—John Hopkinson, F.R.S.

Royal Geographical Society.—Dr. John Murray, F.R.S.

Geological Society.—Dr. Henry Hicks, F.R.S.

Mathematical Society.—Major P. A. MacMahon, R.A., F.R.S.

Physical Society.—Captain W. de W. Abney, F.R.S.

Manchester Literary and Philosophical Society.—Prof. Schuster, F.R.S.

IRELAND.

Royal Irish Academy.—Right Hon. the Earl of Rosse, LL.D., D.C.L., F.R.S.

SCOTLAND.

Edinburgh—Educational Institute of Scotland.—John Dunlop, Esq.

Edinburgh—Royal Society.—Hon. Lord M'Laren.

Glasgow—Geological Society.—Sir Archibald Geikie, LL.D. F.R.S.; J. Barclay Murdoch, Esq.

Glasgow—Institution of Engineers and Shipbuilders.—John Inglis, Esq.

Glasgow—Philosophical Society.—Ebenezer Duncan, M.D.

Other distinguished Visitors.—Professor Cleveland Abbe, Weather Bureau, Washington; John Aitken, F.R.S., Darroch, Falkirk; Prof. Roberts-Austen, C.B., F.R.S., London; Prof. Bayley Balfour, M.D., F.R.S., Edinburgh University; Rev. A. K. H. Boyd, D.D., St. Andrews; A. Hargreaves Brown, M.P., 12 Grosvenor Gardens, London, S.W.; Alexander Buchan, LL.D., 42 Heriot Row, Edinburgh; Professor G. H. Darwin, LL.D., F.R.S., Newnham Grange, Cambridge; Prof. James Dewar, LL.D., F.R.S., Peterhouse, Cambridge; Lowes Dickenson, Esq., 1 All Souls' Place, London, W.; J. D. H. Dickson, M.A., Peterhouse, Cambridge; John M. Dodds, M.A., Peterhouse, Cambridge; Prof. J. A. Ewing, LL.D., F.R.S., Cambridge; Prof. Fitzgerald, Sc.D., Dublin; J. E. Foster, M.A., Cambridge; Prof. Michael Foster, LL.D., F.R.S., Cambridge; Prof. Frankland, F.R.S., Mason College, Birmingham; Ex-Prof. Frederick Fuller, London; David Gill, C.B., LL.D., F.R.S., Astronomer Royal, Cape Town; Dr. Gladstone, F.R.S., London; J. G. Gordon, Esq., London; Prof. Herkomer, R.A., Bushey, Herts.; Sir Joseph D. Hooker, M.D., K.C.B., F.R.S., Sunningdale, Berks; John K. Ingram, LL.D., Dublin; Prof. Alex. B. W. Kennedy, LL.D., F.R.S., London; Hon. Lord Kinnear; Hon. Lord Kyllachy; Count Lovatelli, Italian Embassy, London; Rt. Hon. Prof. Max Müller, LL.D., Oxford; Frank M'Clean, LL.D., F.R.S., Tunbridge Wells; John M'Intyre, M.D., Odiham, Hants; Prof. Simon Newcomb, of Johns Hopkins University, Baltimore, and Nautical Almanac Office, Washington; Prof. Perry, F.R.S., London; Rev. Dr. Porter, Master of Peterhouse, Cambridge; W. H. Preece, C.B., F.R.S., General Post Office, London; Emanuel Ristori, London; Edward J. Routh, D.Sc., LL.D., F.R.S., Peterhouse, Cambridge; Sir William Russell, Adare, Ireland; Right. Hon. Lord Shand, LL.D., London; Alex. Siemens, London; Major-General Sir R. M. Smith, K.C.M.G., Edinburgh; Prof, J. J. Sylvester, M.A., D.C.L., F.R.S., Oxford; James Thomson, M.A., C.E., Newcastle-on-Tyne; Prof. W. A. Tilden, Sc.D., F.R.S., London; Admiral Wharton, R.N., C.B., F.R.S., Admiralty, London.

The only noticeable want in the above list is that of any high Officer of State of our own country. The presence of some member of the Government would have added a touch of State official recognition which it would have done honour to the Government to bestow; but very possibly, like Lord Salisbury and Sir John Gorst, other ministers were unable to leave their posts.

The suite of rooms, unique in extent and convenience for such an assembly, beautiful in themselves because of their architecture and fittings, were further decorated with flowers and plants, and were illuminated by several arc-lamps which shed a bright but mellow light upon the scene. The effect was indescribably brilliant—the splendour of the ladies' dresses, the uniforms, and the municipal and academic robes of the men, mixed with the sober evening attire to which many adhered, rendered the appearance of the rooms during the evening exceedingly picturesque and bright. The east quadrangle was also lighted with the electric light, and formed a most attractive refuge from the hotter atmosphere inside. The band of the Gordon Highlanders discoursed sweet music at intervals from a band stand erected in the centre of the quadrangle, alternating with the pipers of the same regiment, who played a selection of Highland airs in excellent style.

On Tuesday a congregation of the University was held for the presentation of addresses to Lord Kelvin, and the conferring of honorary degrees on Lord Kelvin himself and the principal foreign visitors representative of science. The delegates of the various universities, colleges, societies, and institutions were accommodated

with seats in front of the principal floor-space of the hall, while the chair of the Vice-Chancellor, with chairs for officials, was placed in the centre of a semicircle of professional stalls occupied by the members of the Senatus Academicus, distinguished strangers, and representatives of the Corporation present. For the delegates who were to receive degrees, chairs were set in front of the circle occupied by the Senate. The rest of the hall and the galleries were occupied by students and spectators.

Punctually at 10 a.m. the Senatus with Lord Kelvin at its head, marched in procession up the hall, while the whole assemblage rose and cheered him to the echo. In the absence of Principal Caird, who unfortunately is not yet sufficiently recovered in health to take part in such a ceremony, the chair was taken by Prof. William Gairdner, F.R.S., who, next to Lord Kelvin, is the senior Professor now at Glasgow. After prayer, offered in Latin according to a form which has been long in use at Glasgow, Professor Stewart, Clerk of Senate, read the following letter of congratulation from H.R.H. the Prince of Wales.

Marlborough House,
Pall Mall, S.W.,
June 10, 1896.

Dear Lord Kelvin,—The Prince of Wales desires me to offer you his warmest congratulations upon your having attained the fiftieth year of the tenure of your professorship in the University of Glasgow.

His Royal Highness is in most cordial sympathy with the eminent representatives of universities, learned societies, and other public bodies in different parts of this Empire and in foreign States who, to do you honour, have assembled in the University which has for a long series of years, eventful through the rapid advance of science and its applications, enjoyed the high prestige derived from your close association with its work, and from the invaluable and brilliant contributions to science resulting from the researches carried on by you during the last half-century within its walls.

The Prince of Wales remembers with much satisfaction that he had the gratification seventeen years ago to present you with the medal instituted by the Society of Arts as a memorial of the Prince Consort, and awarded to men who have rendered pre-eminent service in promoting arts, manufactures, and science.

The work which you had at that time accomplished was but an earnest of the important researches to which you have since then devoted yourself so indefatigably, and he cherishes the sincere hope that you may long continue to enjoy the happiness derived from the most gratifying evidence that the high value of the services rendered by you through science to mankind is universally recognised and appreciated.

I remain,
Dear Lord Kelvin,
Yours truly,
Francis Knollys.

P.S.—His Royal Highness desires me to repeat what he has already stated to the University authorities, how greatly he regrets that long-formed engagements in the South prevent him from having the pleasure of being present on the occasion of this interesting celebration.—F. K.

Professor Story then called forward the delegates very nearly in the order in which they are given in the foregoing list. These advanced to the daïs, and presented the messages with which they were charged to Lord Kelvin; and after shaking hands with him, retired to their places. Most of the delegates presented elaborate addresses, beautifully engrossed, and signed by the authorities of the bodies represented. These were not, however, in general read, though a good many delegates made a few pointed remarks when placing the addresses before Lord Kelvin on the table. The delegates of the Institute of France were the bearers to Lord Kelvin of the Arago medal, which has only been three times before bestowed on any one. It is interesting to note in this connection that the Freedom of the City of Glasgow was in 1834 conferred on Arago himself "in testimony of admiration of his high talents and eminent scientific attainments, and particularly of his successful exertions to extend the boundaries of astronomical science."

The medal was presented to Lord Kelvin by Professor E. Mascart, of the Collège de France.

General Ferrero, the Italian Ambassador, attended on behalf of the Royal Institute of Science and Letters of Milan, the Royal Academy of Science, Letters, and Arts of Modena, and the Italian Society of Science, Rome.

The presentation of the addresses of the Royal Society, the University of Cambridge, the students of the four Scottish Universities, the students of the University of Glasgow, and the Senatus of the University of Glasgow excited much interest.

The address of the University of Cambridge, written by the Public Orator, Dr. Sandys, on behalf of the University, was as follows:—

Baroni Kelvin
Regiae Societatis nuper Praesidi
Philosophiae Naturalis inter Glasguenses
per annos quinquaginta Professori
S. P. D.
Universitas Cantabrigiensis.

Dum tot tantaeque Universitates praeceptori tam illustri annos quinquaginta Professoris in munere feliciter exactos certatim gratulantur, Universitati nostrae imprimis consentaneum est ob rem tam laetam tamque honorificam suum gaudium confiteri, suam superbiam testificari. Etenim nostra inter nemora (iuvat recordari) quinquagesimo primo abhinc anno studiorum mathematicorum e certamine primo lauream prope primam reportasti, studiorum eorundem in certamine altero victor renuntiatus. Nostris umbraculis egressus, et alios ex aliis honores serie perpetua propter insignia merita adeptus, physicorum praesertim studiorum provinciam et inventis tuis et exemplo tuo praeclare illustrasti. Tu trans maria magna navigantibus securitatem novam dedisti, septentrionum regionem accuratius indicasti, vada periculosa etiam in ipso transcursu metiri docuisti; tu oceani denique Atlantici litus utrumque vinculo novo coniunxisti. Haec et alia inventa egregia dum contemplamur, non sine superbia recordamur plusquam quinquaginta per annos ipsum inventorem etiam nostra cum Universitate vinculo artissimo fuisse coniunctum. Alumno igitur nostro insigni, non modo annos quinquaginta Professoris in munere prospere peractos, sed etiam vitae annum septuagesimum primum feliciter expletum libenter gratulati, etiam in posterum plurimos per annos omnia fausta ex animo exoptamus. Vale.

Datum Cantabrigiae
mensis Iunii die xi°
A. S. MDCCCXCVI.

L. S.

The following address of the Senatus of the University of Glasgow was read by Professor Stewart, D.D.:—

My Lord,—The rejoicings which have been arranged to celebrate the close of your fiftieth session betoken the admiration and affection with which you are regarded by your colleagues in the Senate, but it is none the less fitting that on this auspicious occasion these feelings should find articulate expression in an address of congratulation. The fifty years during which you have occupied the Chair of Natural Philosophy in this University have to an extent, unparalleled in the history of the world, been marked by brilliant discoveries in every department of physical science, and by the prompt adaptation of many of these discoveries to meet the practical needs of mankind. We recognise with admiration that in both these respects you have been a leader of the age in which we live. Your mathematical and experimental genius has unveiled the secrets of nature; your marvellous gift of utilising such discoveries has ministered in many ways to the happiness and dignity of human life. Your name and your work have been an inspiration to the physicists of the world; new departments of technical industry have sprung into existence under your hand, and even the unlettered have learned to value the gifts which science bestows. The justice of the tributes which have been paid to you by universities and scientific societies at home and abroad, and by the Governments of this and other lands, we are proud to acknowledge. But only your colleagues in university work are in a position to

appreciate the versatility of faculty, the exhaustless energy, and the tenacity of purpose which have enabled you to grapple successfully with problems the most varied, and to reveal to us on every side the reign of order and law. In the midst of all you have endeared yourself to us by the graces of your personal character, notably by that simplicity which, unmarred by honours or success, remains the permanent possession of transcendent genius, and by that humility of spirit which, the clearer the vision of truth becomes, bows with the lowlier reverence before the mystery of the universe.

My Lord, the contemplation of a past so rich in achievements and honours encourages your colleagues to look forward to the future in the hope that you may have health and strength to win new triumphs in years to come, and long to remain among us the ornament and the glory of our ancient University.

William Stewart.
Clerk of Session.

The address from the Royal Society was presented by the President, Sir Joseph Lister, Bart., and the Treasurer, Sir John Evans, K.C.B. It ran as follows :—

The Royal Society.

Dear Lord Kelvin,—The President, Council, and Fellows of the Royal Society desire, on the happy occasion of the jubilee of your Professoriate in the University of Glasgow, not only to be represented, as they are, by their highest officers, the President and Treasurer, but also to assure you, by some direct words, of the warm sympathy of the whole Society.

There is no need to dwell on the many ways in which you have contributed to that improvement of natural knowledge to secure which the Society was founded, or on the many valuable communications with which you have enriched the Society's records. Since you first joined the Society, and the jubilee of that event is not far off, the Society has always known how much your belonging to it has added to its strength ; but it has been especially during the recent five years, which went too swiftly by, while you filled in so admirable a manner the chair of President, that the Society has felt how close are the ties which bind it to you and you to it.

We ask you to receive our heartiest congratulations on the present glad event, and our warmest wishes for your welfare in the years yet to come.

(Signed) Joseph Lister, Pres. R.S.

When the presentation of addresses had been completed, Professor Moody Stuart, Dean of the Faculty of Law, amid great and prolonged applause presented Lord Kelvin for the degree of Doctor of Laws. "As a memorial," he said, "of this day, the Senate desire to confer on Lord Kelvin the highest honour they have to bestow, by placing his illustrious name on the roll of Doctors of Laws of the University."

The ceremony of capping was performed by Professor Gairdner, amid a renewed outburst of cheering.

Lord Kelvin thereafter took the chair as Senior Professor in the University, and proceeded to confer the remainder of the honorary degrees.

Prof. Moody Stuart, in presenting the recipients, said :— The Senate desire to commemorate this occasion by conferring the honorary degree of Doctor of Laws on some of the distinguished men of science from the continent of Europe, from the United States of America, and from the British Colonies, who have honoured the University by their presence to-day. In the name of the Faculty of Law, and by authority of the Senate, I have now the honour of presenting them for this degree.

Prof. Cleveland Abbe, head of the Meteorological Office, Washington, distinguished for his important contributions to astronomical and meteorological science.

Prof. Christian Christiansen, Copenhagen, author of many important papers on physical science, and of a most beautiful experimental illustration of differences of refractivity at different temperatures.

Prof. Per Theodore Cleve, of Upsala, long esteemed as one of the most notable workers in chemical and mineralogical science. His name has become known to a wider public in connection with the discovery of helium in the mineral Cleveite named after him.

His Excellency General Annibale Ferrero, Ambassador to this country from His Majesty the King of Italy. General Ferrero is specially eminent in mathematical and geodetical science, and, notwithstanding the engrossing duties of his high office, continues to take his part in the scientific work to which his life has been devoted.

Prof. Izidor Fröhlich, of the University of Buda-Pesth and Academy of Sciences, Buda-Pesth, who has published a large number of important papers on physical optics and on electricity.

Prof. Gabriel Lippmann, of the Sorbonne, Paris, inventor of the capillary electrometer and discoverer of the principles of true colour photography.

Prof. Archibald Liversidge, of the University of Sydney, New South Wales, Dean of Faculties in that university, distinguished as a traveller, a chemist, and a geologist.

Prof. Eleuthère Mascart, official head of meteorology in France, a physicist of great reputation, and author of a very important treatise on electricity.

Prof. Henri Moissan, of the University of France, one of the most originative and practical of modern chemists.

Prof. Simon Newcomb, of Johns Hopkins University, Baltimore, whose numerous researches have contributed largely to the progress of gravitational astronomy, the most notable being his work on the satellites of Saturn and his researches on the motion of the moon. He was awarded the Copley Medal of the Royal Society of London in 1890.

Prof. Nikolai Aleksejevich Oumov, of the University of Moscow, who has gained great distinction by his researches on energy and on electro-dynamic induction.

Prof. Émile Picard, of the University of France, who holds a leading position among the great French mathematicians.

Prof. Georg Quincke, of the University of Heidelberg, one of the most famous experimental physicists in Germany, author of numerous important experimental investigations, among others on capillarity and in optics.

Prof. Woldemar Voigt, of the University of Göttingen, well known as the author of numerous papers on the mathematical theory of light and on the electricity of crystals.

Lord Kelvin then said—The University of Glasgow is honoured by the presence to-day of many distinguished visitors from foreign countries, from America, from India, from Australia, and from all parts of the United Kingdom. Names of men renowned for their scientific work in distant countries have been added to our list of honorary graduates. That I have had the honour of conferring these degrees in the name of the University is a subject of keenest regret to all here present, because it is due to the absence of Principal Caird on account of illness. We hope that the beginning of next session will see him at home in the University with thoroughly recovered health. In his absence the duty of conferring degrees has fallen, according to University law, on me as senior Professor present. I am also one of the recipients of the degree, and, in the name of all who have to-day been created Doctors of Laws of the University of Glasgow, I thank the Senate for the honour which we have thus received on the occasion of the jubilee of my professorship. For myself, I can find no words to express my feelings on this occasion. My fifty happy years of life and work as Professor of Natural Philosophy here, among my students and my colleagues of the University and my many kind friends in the great City of Glasgow, call for gratitude ; I cannot think of them without heartfelt gratitude. But now you heap coals of fire on my head. You reward me for having enjoyed for fifty years the privilege of spending my time in the work most congenial to me and in the happiest of surroundings. You could not do more for me if I had spent my life in hardships and dangers, fighting for my country, or struggling to do good among the masses of our population, or working for the benefit of the people in public duty voluntarily accepted. I have had the honour to receive here to-day a gracious message from His Royal Highness the Prince of Wales, and addresses from sister-universities in all parts of the world ; from learned societies, academies, associations, and institutions for the advancement of pure and applied science ; from municipal corporations and other public bodies ; from submarine telegraph companies, and from their officers, my old comrades in their work ; from students, professors, and scientific workers of England, Scotland, and Ireland and other countries, including my revered and loved St. Peter's College, Cambridge, and my twenty Baltimore coefficients of 1884. The term coefficients is abused by mathematicians. They use it for one of the two factors of the result. To me the professor and his class of students are coefficients, fellow-workers, each con-

tributing to whatever can possibly be done by their daily meetings together. I dislike the term lecture applied here. I prefer the French expression—"conference." I feel that every meeting of a professor with his students is rather a conference than a pumping in of doctrine from the professor, perhaps ill-understood and not well received by his students. The Scottish universities have enabled us to carry out this French idea of conference. In many of our classes the professor is accustomed to converse with his students sometimes in the form of *viva voce* examination and oftener, I hope, in the manner of the interchange of thoughts, the professor discovering whether or not the student is following his lecture, and being thus really helped in his treatment of the subject. I have had addresses also from my old Japanese students of Glasgow University, now professors in the University of Tōkiō, or occupying posts in the Civil Service and Engineering Service of Japan, for which I thank them heartily. I wish particularly also to thank my Baltimore coefficients for their address. They have been useful to myself in my own keen endeavour—unsuccessful, I must say—nevertheless keen—to know something about the true dynamics of light and ether and crystals. The addresses which I have received to-day contain liberal and friendly appreciation of all my published mathematical and physical papers, beginning in 1840, and ending—not yet I hope. The small proportion of that long series of writings which has led to some definite advancement of science is amply credited for its results. The larger part, for which so much cannot be said, is treated with unfailing and sympathetic kindness as a record of persevering endeavour to see below the surface of matter. It has been carried on in the faith that the time is to come when much that is now dark in physical science shall be seen bright and clear, if not by ourselves, by our successors in the work. I am much gratified by the generous manner in which these addresses have referred to the practical applications of science in my work for submarine telegraphy; my contributions to the advancement of theoretical and practical knowledge of the tides; my improvements in the oldest and next oldest of scientific aids to navigation, the sounding plummet and the mariner's compass; and my electric measuring instruments for scientific laboratories, for the observation of atmospheric electricity, and for electrical engineering. I now ask the distinguished men who have honoured me by presenting to me these addresses to accept for themselves personally, and for the societies represented by them, my warmest thanks for the great treasure which I have thus received—good will, kindness, friendship, sympathy, encouragement for more work—a treasure of which no words can adequately describe the value. I cordially thank the French Academy of Sciences for their great kindness in sending me by the hands of my loved and highly esteemed colleague Prof. Mascart the Arago Medal of the Institute of France. I thank all present in this great assembly for their kindness, which touches me deeply; and I thank the City and University of Glasgow for the crowning honour of my life which they have conferred on me by holding a commemoration of the Jubilee of my Professorship.

A more dignified and imposing ceremony than that which was now closed with the benediction pronounced by Prof. Stewart, was never witnessed at the University of Glasgow. Anything more striking and impressive of an academic nature it is hardly possible to conceive. The demeanour of the students and general public was respectful, and at the same time displayed the most enthusiastic regard for the hero of the occasion, and all the arrangements worked without the slightest hitch or fault.

In the evening at seven o'clock a grand banquet was given in the St. Andrews Halls to about six hundred gentlemen, including all the delegates and other distinguished strangers present at the celebration. On the platform of the hall three principal tables were arranged, at which were seated the Lord Provost, with Lord Kelvin and other gentlemen, who were afterwards to speak, or who, for various reasons, it was proper should be so honoured.

The Lord Provost occupied the chair at the first table, and was supported on the right by Lord Kelvin, His Excellency General Annibale Ferrero, the Italian Ambassador, the Right Hon. Lord Rayleigh, D.C.L., LL.D., F.R.S., Prof. Newcomb (Washington), Lord Overtoun, the Lord Justice General of Scotland, Prof. Picard (Paris), Lord Shand, General Sir Archibald Alison, Bart.; and on the left by the Earl of Rosse, K.P. (Chancellor of the University of Dublin), Sir Joseph Lister, Bart. (President of the Royal Society), Lord Napier and Ettrick, Prof. Quincke (Heidelberg), Dr. Gill (Astronomer-Royal, Cape of Good Hope), Signor Montefiore Levi (Brussels), Prof. Abbe (Washington), James A. Campbell, LL.D., M.P.

On the main floor of the hall were arranged fourteen tables, accommodating about forty guests each. The length of each table ran at right angles to the platform, so that each person could regard the after-dinner speakers comfortably without changing his position.

After dinner the front seats of the galleries round the hall were occupied by ladies, who had previously been received on entrance by Lady Bell and Mrs. Caird.

The Lord Provost began by saying—I have been entrusted with a message from Her Majesty the Queen, and, as is customary, I would ask you to stand while Her Majesty's message is being read. It is as follows:—

The Queen commands me to beg that you will kindly express to Lord Kelvin her Majesty's sincere congratulations on the occasion of the jubilee of his professorship in the Glasgow University. Her Majesty trusts that many years of health and prosperity may be in store for him and Lady Kelvin. The Queen is particularly gratified at the presence of so many eminent representatives from all countries of the world who have come to do honour to your distinguished guest.—(Signed) Arthur Bigge, on behalf of her Majesty.

This message was received with great applause by the company, and the knowledge that Her Majesty had joined her congratulations to those of the whole scientific world gave great and evident pleasure.

After the toasts of Her Majesty the Queen, the Prince and Princess of Wales, and the other members of the Royal Family had been duly honoured, the Lord Justice General of Scotland proposed that of the Houses of Parliament, coupling it with the names of Lord Rayleigh and Dr. James A. Campbell, member of Parliament for the Glasgow and Aberdeen Universities.

In concluding his reply on behalf of the House of Lords, Lord Rayleigh said:—

I suppose there are not very many here present who have followed more closely than I have done the writings with which our guest has furthered science for many years. It would be a commonplace to say that much which now passes as current science has its origin in those writings. But what gives to me more to think about, what is to me a matter of deeply-felt gratitude, is the twenty or twenty-five years' friendship with him that it has been my own privilege to enjoy—a friendship enlivened by many discussions, some perhaps not without a spice of controversy; but it would be difficult to convey the deep debt of gratitude due for all I have learned from him, in his writings or in his stimulating conversation. I feel, however, if I were to enlarge upon this subject, I should be very soon called to order, because I should be trenching on a toast which is soon to be proposed; but I feel I cannot abstain from saying a few words as a result of the very heartfelt feelings which I have on this subject.

The Lord Provost, in a most excellent and appreciative speech, next proposed the toast of the evening. He began by reading cable messages from the University of Toronto and the students of the University of Moscow. The latter ran as follows:—

To the celebrated Lord Kelvin, famous, learned, we send our congratulations, the Moscow University Students.

Telegrams of regret for absence were read from Lord Salisbury, Sir John Gorst, and others. The Lord Provost also read the following letter from the Principal of the University, unhappily laid aside by illness:—

The University, Glasgow, June 10, 1896.

My dear Sir James,—Will you allow me to express to you and to any others who may chance to notice my absence, my great disappointment and regret that I am not permitted to be

present next week at the banquet at which you are to preside, or at any of the other functions in connection with Lord Kelvin's jubilee. It would have been a great gratification to me to take part in the universal tribute of admiration and respect that is to be paid to the great man of science, and to give public expression to the esteem and affection which for many a long year I have felt for him as my colleague and friend. Acting under medical advice, however, I am reluctantly constrained, owing to a recent illness, from which I have not yet completely recovered, to refrain from taking part in the approaching ceremonials.—Very truly yours, (Signed) J. CAIRD.

The Lord Provost then proceeded, and, after a very interesting, but necessarily brief, sketch of Lord Kelvin's career, he concluded with the following graceful words:—

This life of unwearied industry, of universal honour, has left Lord Kelvin with a lovable nature that charms all with whom he comes in contact. Unaffected, ever wishful to get the opinions of others, courteous and kind, well might Prof. Huxley, after a memorable controversy, introduce Lord Kelvin as his successor in the presidency of the British Association with these words:—"Gentler knight never broke lance." Lord Kelvin, indeed, inspires love and reverence in all. His home life is love and melody. His helpmate is worthy of him, and greater cannot be said. Those who have the great privilege of their friendship, will in their hearts with fervent prayer add to the toast the wish that Lord and Lady Kelvin may long be spared to one another. I give you "Lord Kelvin, and hearty congratulations on the attainment of his jubilee."

The toast was pledged with great enthusiasm, and, on the call of the Lord Provost, cheers were raised for Lady Kelvin, the entire company rising and waving handkerchiefs. The cheering was again renewed when the organist played "See the Conquering Hero," followed by "For He's a Jolly Good Fellow," in which the company joined *con amore*.

On rising to respond, Lord Kelvin was greeted with enthusiastic applause. He said—

My Lord Provost, your Excellency, my Lords, and gentlemen,—First of all, I desire to express the deep and heartfelt gratitude with which I have heard the most kind and gracious message from Her Majesty the Queen, which has been read to us by the Lord Provost. But I cannot find words for thanks. I can only, on the part of Lady Kelvin and myself, tender an expression of our loving loyalty to the Queen. My Lord Provost, my Lords, and gentlemen, I thank you with my whole heart for your kindness to me this evening. You have come here to commemorate the jubilee of my University professorship, and I am deeply sensible of the warm sympathy with which you have received the kind expressions of the Lord Provost regarding myself in his review of my fifty years' service, and his most friendly appreciation of practical results which have come from my scientific work. I might perhaps rightly feel pride in knowing that the University and City of Glasgow have joined in conferring on me the great honour of holding this jubilee, and that so many friends and so many distinguished men, friends and comrades—day-labourers in science, have come from near and far to assist in its celebration, and that congratulations and good wishes have poured in on me by letter and telegram from all parts of the world. I do feel profoundly grateful. But when I think how infinitely little is all that I have done, I cannot feel pride; I only see the great kindness of my scientific comrades, and of all my friends, in crediting me for so much. One word characterises the most strenuous of the efforts for the advancement of science that I have made perseveringly during fifty-five years; that word is failure. I know no more of electric and magnetic force or of the relation between ether, electricity, and ponderable matter, or of chemical affinity, than I knew and tried to teach to my students of natural philosophy fifty years ago in my first session as Professor. Something of sadness must come of failure; but in the pursuit of science, inborn necessity to make the effort brings with it much of the *certaminis gaudia*—and saves the naturalist from being wholly miserable, perhaps even allows him to be fairly happy, in his daily work. And what splendid compensations for philosophical failures we have had in the admirable discoveries by observation and experiment on the properties of matter, and in the exquisitely beneficent applications of science to the use of mankind with which these fifty years have so abounded! You, my Lord Provost, have remarked that I have had the good fortune to remain for fifty years in one post. I cordially reply that for me they have been happy years. I cannot forget that the happiness of Glasgow University both for students and professors is largely due to the friendly and genial City of Glasgow in the midst of which it lives. To live among friends is the primary essential of happiness; and that, my memory tells me, we inhabitants of the University have enjoyed since I first came to live in it in 1832, sixty-four years ago! And when friendly neighbours confer material benefits, such as the citizens of Glasgow have conferred on their University in so largely helping to give it its present beautiful site and buildings, the debt of happiness due to them is notably increased. I do not forget the charms of the old college in the High Street and Vennel, not very far from the comforts of the Saltmarket, which was my home from 1832 till 1870. Indeed, I remember well when, in 1839, the old Natural Philosophy class-room and apparatus-room (no physical laboratory then) was almost an earthly paradise to my youthful mind. And the old College Green, with the ideal memories of Osbaldistone and Rashleigh and their duel, and Rob Roy intervening to prevent bloodshed, created for it by Sir Walter Scott, was attractive and refreshing to the end. But density of smoke and of crowded population in the adjoining lanes increased, and pleasantness, healthiness, and convenience of the old College both for students and professors diminished year by year. If, my Lord Provost, your predecessors of the Town Council, and the citizens of Glasgow, and wellwishers to the city and its university all over the world, and the Government, and the great railway company that has taken the old college for a passenger and goods station, had left us undisturbed on our ancient site, and had not given us our new college, I do not believe that attractions elsewhere would have taken me away from the old college—but I do say that the fifty years of professorship which I have enjoyed would have been less bright and happy, and I believe also less effective in respect to scientific work, than they have been with the great advantages with which the University of Glasgow has been endowed since its migration from the High Street. My Lord Provost, I ask you to communicate to your colleagues of the Town Council my warmest thanks for their great kindness to me in joining with the University to celebrate this jubilee. Your Excellency, my Lords, and gentlemen, I thank you all for the kind manner in which you have received the toast of my health proposed by the Lord Provost, and for your presence this evening to express your good wishes for myself.

Prof. W. T. Gairdner, F.R.S., in an interesting speech, proposed the representatives present from other Universities and learned bodies, coupling it with the names of His Excellency General Annibale Ferrero, Ambassador for Italy, Sir Joseph Lister, President of the Royal Society, and Prof. Simon Newcomb, Washington. These gentlemen replied as follows.

His Excellency General Annibale Ferrero, Ambassador for Italy, who, in acknowledging the compliment, spoke in French, said—My Lords, Ladies, and Gentlemen, when the honour was done me of asking me to speak in the name of so many illustrious men, I thought that it would be great hardihood on my part to accept a duty which would have better suited men whose name had already a place in the history of science. However, I thought that I had the honour of representing a country from which there have come great predecessors of Lord Kelvin, such as Galileo, Volta, and Galvani. In coming here to represent the scientific bodies of our respective countries we have merely the desire to render homage to the man of genius whose jubilee is being celebrated by the University of Glasgow, which has the honour of possessing him. But our presence is also intended to show that the whole scientific world desires to take part in recognising the services which Lord Kelvin has rendered to the human race. The light which shines to-day upon the University of Glasgow is like that of the sun. It does not belong to one country but extends to all nations. We owe special thanks to Prof. Gairdner for the way in which he has proposed the toast of the representatives of other institutions and learned bodies. We also owe a tribute of gratitude to the Corporation of Glasgow for the cordial and dignified welcome which has been accorded us. We have taken part in this jubilee celebration with the most lively feeling of admiration for the great man who is its object. The noble ceremony which we witnessed to-day in the University raised our spirits and touched our hearts. I cannot

better express our common thought than by saying that we have taken part in the apotheosis of science. I conclude by expressing the kindest wishes to the University of Glasgow, and our gratitude to Providence for having confided to us an incalculable treasure in the person of Lord Kelvin. May he be long spared to humanity.

Sir Joseph Lister said—My Lord Provost, my Lords and gentlemen, I have to thank Prof. Gairdner, my old friend, for the kind words in which he has referred to myself in the close of his speech, and this most distinguished company for the manner in which they have been received. It has been to myself a matter of unalloyed satisfaction to attend this grand celebration. A jubilee is sometimes attended with melancholy when it is felt that the man in whose honour it is held is failing in body and in mind, and that his life's work is over. No such cloud hangs over us to-day. It is true, as you are all aware, that some months ago Lord Kelvin experienced some indisposition. There was felt anxiety in some quarters, whether it might be prudent for him to undergo the fatigue and excitement necessarily attendant upon an occasion like this. Lord Kelvin came to London some weeks since, and he did me, as an old colleague, the honour of asking my advice. I looked into his case as carefully as I could, and it seemed to me that his ailment had been in its origin purely local, implying nothing of constitutional defect, and giving no reason to apprehend any ultimate impairment of bodily or mental vigour. A certain amount of care had been required at the outset, and this had been taken under the direction of the eminent men whose advice he had had in Glasgow; and I agreed with them in the opinion that the care might be gradually relaxed; and finally I took upon myself the somewhat serious responsibility of giving to Lord Kelvin *carte blanche* to behave as any ordinary mortal might do. Now, gentlemen, I venture to think that what we have seen and heard of Lord Kelvin in the course of the last two days justifies my boldness, and that we may confidently look forward to the fulfilment of the hope which he expressed this morning, that he may yet for many years to come pursue with unabated energy those magnificent researches which have already done so much to benefit humanity. There is another aspect of this occasion with regard to which I should like to say a word. It has been to me a matter of very great pleasure to witness the splendid vitality and vigour of the school in which I had once the honour of being a teacher. in palatial buildings, which may well excite the envy of us Londoners—a true teaching university in the full tide of prosperity and usefulness. I have also been exceedingly pleased to observe the friendly co-operation between the university and the municipality, of which this magnificent banquet is of itself sufficient evidence. The electrical illumination of the college buildings, which so largely promoted the success of last night's entertainment, was due to the liberality of the municipality, guided by the wise and bold policy of the Lord Provost. I visited to-day the Botanic Garden—that indispensable adjunct of an efficient university. In former days these gardens produced a painful impression upon those who visited them. They gave too clear an evidence that science was confined and cribbed for want of pecuniary means. Now all this is altered. The beautiful site has been extended and embellished, magnificent new houses have been erected, and everything bears the stamp on the one hand of scientific wisdom in their management, and on the other hand of ample resources. Now, all this is due to the beneficent rule of the municipality of Glasgow. I feel, therefore, that whether I look at this great celebration with regard to its essential object—the homage of the scientific world to our illustrious friend—or to the evidence which it has afforded of the prosperity of the University and the wise liberality of this great city, it has given me unmixed pleasure; and it has been a high privilege to have been permitted to take part in it.

Exhibition of diplomas and instruments, showing telegraph receiving and sending instruments, used for receiving and replying to congratulatory messages.

Prof. Simon Newcomb, Washington, U.S., replied for the Americans. He remarked—I feel that an apology is due to you in accepting the invitation to speak this evening, and thereby imperilling a certain reputation which I believe my country has for grace in after-dinner speeches. The fact is, that until it was too late I was really not aware America would have so many representatives here better able than I am to do justice to the occasion. But there is yet another reason why I was extremely unwilling to voice the sentiments which I know are entertained by all Americans on the present occasion. If among the friends of Lord Kelvin, who for twenty-five years have been in more or less intimate association with him, that one was to be selected of whom during that period he had most kindly spoken, and

awarded a praise that was perhaps the least deserved, I think it would have been the humble individual who now has the honour of addressing you. As Americans, you are aware how very close is our association with the great man of science whose jubilee we now celebrate. He first became known to us through his work in connection with the Atlantic cable of 1858, a cable which, those of you who now can remember it, ceased after a week or two of rather intermittent activity. It is quite true that on that occasion his fame was temporarily eclipsed by that of the operator who sent the messages from the end in Newfoundland. The name of this operator ran from city to city throughout the country. It had never been heard of before; it filled the land for those few brief days, and when the cable ceased to send the current, it disappeared almost for ever. For an explanation we had to refer to one of our most eminent men of science, who has lived, I think, wherever the English language is spoken—the author of the "Autocrat of the Breakfast Table"—and who published a theory or explanation of the whole phenomenon. This man was a living product of the galvanic action of the cable, and when the current ceased to pass, there was nothing left in the room he occupied but a cloud of organic elements such as man is made of. On the subsequent occasion of laying the cable in 1866, our guest again became well known to us for his work in promoting that object. Also, in our naval service, to which I have the honour to belong, we are in many ways most indebted to him. I do not think the name of any man is more familiar to the officers of our navy anywhere than that of Lord Kelvin, first, by his work on magnetism, and for the navigation of ships, and by his deep-sea sounding apparatus, as well as by many others of his inventions which relate to navigation. There are certain features of his work which, as one so long intimately associated with him, it may not be amiss that I recall. The first, and perhaps most unique, feature is the combination of abstract results with practical application. It has been the general—I do not know but that it has been the almost universal—rule that the men who have by their studies and thought promoted our knowledge of nature have not been those who have applied that knowledge to the direct benefit of mankind by inventing means for its application. I am not sure but that Lord Kelvin is the single, solitary exception to this rule. The ground covered by his work is certainly remarkable in its extent. The first knowledge I had of him—probably the first that those who cultivate mathematics know of him—is in connection with a journal published back in the forties, and known under different names at different times as the *Cambridge, London, and Dublin Mathematical Journal*. For a period, I believe, he was associated in the editorship of that journal. Now, it is worthy of remark in this connection, that at the present time sets of this journal can command a price that is almost fabulous in the public market from the mathematicians of the day. Then at this point he diverged from the doctrine which was said to have been laid down by one of the most eminent workers in the words, "I thank Heaven that I cultivate a science which cannot be prostituted to any useful purpose." In passing from the field of mathematics we come next to pure philosophy by saying that the theory of energy in its present form is, I think, very largely due to his work. This is, perhaps, the most far-reaching generalisation as to the laws of action that the world has seen; it enables us to see the beginning of the universe and to look forward towards its end. We all read discussions as to the age of the earth and the question whether the geologist has an indefinite bank of time on which he can draw cheques without limit. Yet another question of geology was that of the rigidity of the earth, in which I think his view is almost universally accepted. In this wide range of activity I think we may say that he has made few mistakes—perhaps we may say that he is almost unique in not having made any. I beg leave, on behalf of the foreign representatives, to thank you, my Lord Provost and the citizens of Glasgow for the very cordial reception we have met in coming here to present our congratulations to Lord Kelvin on this memorable occasion. We shall ever remember that reception, and I beg leave on behalf of all to again express the hope that our honoured guest of this evening may live for many years.

Prof. Story, at the suggestion of the Lord Provost, very gracefully proposed the health of Lady Kelvin, which was received with great applause. Lady Kelvin, who occupied a seat in the balcony, bowed her acknowledgments, and Lord Kelvin, replying for her, said—

Prof. Story has said well that I owe a great deal to Lady Kelvin, but he does not know how much I owe. No person in the world except myself knows how much of any results for science that it has been possible for me to arrive at are due to her co-operation. I thank you warmly for the very kind manner in which you, Prof. Story, have proposed this toast, and with which the company have received it.

After the toasts of the University and City of Glasgow, proposed by the Earl of Rosse, D.C.L., F.R.S., and the Lord Provost, proposed by Sir Henry Roscoe, F.R.S., had been duly honoured and replied to, the company joined in singing "God Save the Queen," and afterwards, on the request of Lord Kelvin, in singing "Auld Lang Syne."

Thus closed the celebration proper, a celebration almost unique in the experience of every one present for its grand simplicity, splendid enthusiasm, and entire success in every detail of arrangement. For the latter characteristic the Jubilee Committee deserve the highest credit, and its Secretaries, and others, among whom are the Rev. Professor Stewart, D.D., Clerk of Senate, Mr. Allen Baird, and members of the Senatus, who had charge of the University arrangements, may well be proud of the result of their labours.

Nothing in Lord Kelvin's reply to the toast of his health at the banquet was more characteristic of the man than his humble confession of failure to penetrate the mystery of the constitution of matter and of ether. It is no doubt true, as Lord Kelvin remarked, that the nature of electric and magnetic force, and the relation between ether, electricity, and ponderable matter, are still unknown to us; but Lord Kelvin's researches have been the means of enabling himself and others to unravel many of their phenomena, to connect these phenomena by general laws, and to marshal the forces of science for still further assaults on the unknown. The *certaminis gaudia* is not after all in this case mere joy of conflict, but the pleasure of obtaining by strenuous endeavour some view first of the very innermost secrets of nature, and what is of very great consequence and may in time include everything, an accurate conception of her method of working, and of the dynamical laws which govern her operations.

A number of delegates and others left Glasgow on Wednesday morning, but many remained and accepted the invitation of the Senatus to a special excursion on the Firth of Clyde. A special train was run from St. Enoch's station to Greenock, where the steamer *Glen Sannox* awaited the party. The morning was wet, but the ample saloon accommodation of the splendid steamer, with an awning erected on deck, provided sufficient shelter. The steamer headed down the Clyde instead of proceeding up Loch Long, where it was likely to be raining still more heavily, and proceeded past Largs, saluting Nether Hall, Lord Kelvin's country house at Largs, in passing, thence between the Cumbraes to the mouth of Loch Fyne, then round the Kyles of Bute, and back to Greenock in time to allow Glasgow to be reached before the departure of the limited mail train in the evening. Luncheon and tea were served on board. The weather cleared about midday, and the excursion proved most enjoyable to all, and there were many who ventured to go. Lord and Lady Kelvin with their party were present, and, it was gratifying to observe, seemed to be in excellent health and spirits in spite of the excitement and fatigues of the previous days.

A. Gray.

INTERNATIONAL CATALOGUE OF SCIENCE.

The approaching International Conference arranged by the Royal Society to consider proposals for an International Catalogue of Scientific Literature will be formally opened at the apartments of the Society in Burlington House on the morning of Tuesday, July 14. A reception of the delegates will be held by the

President of the Royal Society on the previous evening at Burlington House, and they will be entertained at dinner by the Society on the evening of the 14th at the Hôtel Métropole. On the 15th the delegates will be received by the Lord Mayor at the Mansion House, and on the afternoon of the 16th they will be entertained by Dr. Ludwig Mond, F.R.S., at a garden party at his house in Avenue Road. The total number of delegates appointed to attend the Conference amounts to forty, including representatives of the principal colonies of the Empire and the principal Governments of the world.

The following is a list of the delegates appointed to attend the Conference.

AUSTRIA.—Prof. Dr. Edmund Weiss; Prof. Dr. Ernst Mach.

BELGIUM.—Chevalier Descamps-David (President Institut International de Bibliographie); M. de Wulf (Member Institut International de Bibliographie); M. Paul Otlet (Member Institut International de Bibliographie).

BRAZIL.—Dr. João Ribeiro (Professor "Gymnasio Nacional").

DENMARK.—Prof. Christiansen (Universitet, Copenhagen).

FRANCE.—Prof. A. Milne-Edwards (Membre de l'Institut, &c.); Prof. G. Darboux (Membre de l'Institut, &c.); Prof. Troost (Membre de l'Institut, &c.); Dr. J. Deniker (Librarian, Muséum d'Histoire Naturelle, Paris).

GERMANY.—(Names not yet received).

GREECE.—M. Avierinos M. Averoff (Greek Consul at Edinburgh).

HUNGARY.—Prof. August Heller (Librarian, Ungarische Akademie, Buda-Pesth); Dr. Theodore Duka (London).

ITALY.—General Annibale Ferrero (Italian Ambassador in London).

JAPAN.—Hantaro Nagaoka (Assistant Professor, Science College, Tōkiō); Gakutaro Ozawa (Assistant Professor, Medical College, Tōkiō).

MEXICO.—Señor Don Francisco del Paso y Ironcoso.

NETHERLANDS.—Prof. D. J. Korteweg (Universiteit, Amsterdam).

NORWAY.—(Names not yet received).

PORTUGAL.—The Portuguese Minister in London (Señhor D'Antas).

RUSSIA.—Privy Councillor Stasow (First Librarian, Imper. Publičnaja Biblioteka, St. Petersburg).

SWEDEN.—Dr. E. W. Dahlgren (Librarian, Kongl. Svenska Vetenskaps Akademie, Stockholm).

SWITZERLAND.—The Swiss Minister in London (M. Bourcart); Prof. Dr. F. A. Forel (Président du Comité Central de la Société Helvétique des Sciences Naturelles).

UNITED KINGDOM.—Representing the Government: Right Hon. Sir John E. Gorst, M.P. (Vice-President of the Committee of Council on Education). Representing the Royal Society of London: Prof. Michael Foster, Sec. R.S., Prof. H. E. Armstrong, F.R.S., Mr. J. Norman Lockyer, C.B., F.R.S., Dr. Ludwig Mond, F.R.S., Prof. A. W. Rücker, F.R.S.

UNITED STATES.—Dr. John S. Billings (U.S. Army); Prof. Simon Newcomb, For. Mem. R.S. (U.S. Nautical Almanac Office).

CANADA.—The High Commissioner for Canada (the Hon. Sir Donald A. Smith, G.C.M.G.).

CAPE COLONY.—Mr. Roland Trimen, F.R.S.

INDIA.—General Sir Richard Strachey, F.R.S.

NATAL.—The Agent-General for Natal (Walter Peace, C.M.G.).

NEW SOUTH WALES.—(Appointment awaiting confirmation).

NEW ZEALAND.—The Agent-General for New Zealand (the Hon. W. P. Reeves).

QUEENSLAND.—The Agent-General for Queensland.

NOTES.

WE are asked to state that a zoologist with experience of deep-sea dredging is required for the Belgian Antarctic expedition. Intending applicants should communicate with Lieut. de Gerlache, Commander of the expedition, at Sandefiord, Norway.

PROF. DR. G. NEUMAYER, the Director of the Deutsche Seewarte, reached his seventieth birthday on Sunday last. We join with German scientific papers in congratulating Prof. Neumayer upon his numerous contributions to natural knowledge, and in the hope that science may have the benefit of his assistance for many years to come.

DR. D. GILL, F.R.S., has been elected a Correspondant of the Paris Academy of Sciences.

WE regret to announce that Sir Joseph Prestwich died on Tuesday morning, after a short illness. By his death science has lost a devoted student, whose numerous papers in the various departments of theoretical, observational, and practical geology testify to a career of earnest and careful work. He was born in in 1812, and became a Fellow of the Royal Society in 1853.

MR. J. H. MAIDEN has been appointed Government Botanist and Director of the Botanic Gardens at Sydney, in succession to Mr. Charles Moore, who has recently retired after a service, in these capacities, of nearly half a century.

MAJOR ARTHUR GRIFFITHS, one of her Majesty's Inspectors of Prisons, has been appointed by the Home Secretary to represent her Majesty's Government at the International Congress of Criminal Anthropology to be held at Geneva in August next.

WITH reference to the tornado at St. Louis on May 27, we learn from *Science* that, with commendable promptness, the Washington Weather Bureau issued, on May 29, a special storm-bulletin showing the weather conditions over the United States on May 26–28. The Chicago 8h. a.m. forecast on May 27 predicted severe thunderstorms for Illinois and adjoining States during the latter part of the day, and a special warning was issued from Washington at 10h. 10m. on that morning.

THE Northern Province of Japan has recently been visited by a series of destructive earthquakes. Within twenty hours, on the 15th and 16th insts., no less than 150 shocks were felt. Nearly the whole of the town of Kamaishi has been destroyed, with the reported loss of one thousand lives. Three of the shocks appear to have been of exceptional severity, for, according to information we have received from Prof. Vicentini, they were registered by his microseismograph at Padua. The first pulsations began there at 10h. 45m. a.m. (Greenwich mean time) on the 15th, and lasted till 0h. 10m. p.m.; the second continued from 7h. 28m. to 8h. 30m. p.m.; the third and strongest began at 11h. 14m. p.m., and ended at 0h. 2m. a.m. on the 16th inst. The great sea-wave, which accompanied the earthquake, extended over seventy miles of the north-east coast of Japan, destroying many towns, and drowning, it is feared, about ten housand persons.

A DEVOTED student of natural history, whose name is known to most zoologists, and whose observations have greatly enriched ornithology, has just passed away in the person of Lord Lilford. Numerous notes by him on British birds, and on the ornithology of Spain and of the shores of the Mediterranean, have appeared in the *Zoologist* and the *Ibis*, the journal of the British Ornithologists' Union, of which he was President. Last year he published an excellent volume on the birds of his native county, Northamptonshire, with beautiful illustrations, and the thirty-second part of his "Coloured Figures of the Birds of the British Islands," which was issued only in April last, almost

completes that work. Lord Lilford will be remembered and regretted by naturalists all over the world.

M. TONY NOËL has (says the *British Medical Journal*) just finished a statue of Pasteur, to be placed in the market-place of Alais, where the illustrious investigator made his researches in the diseases of silkworms. The statue is declared by the relatives and friends of M. Pasteur to be an excellent likeness, and artistically it is a very successful piece of work. Pasteur is represented erect, gazing fixedly at a sprig of mulberry covered with cocoons which he holds in his left hand. At his feet is a young girl in a graceful attitude handing him other cocoons. Near at hand are a microscope and a box of scientific instruments. M. Berthelot, who in company with M. Roux carefully inspected the statue, is said to have exclaimed: "Je revois Pasteur tel qu'il était il-y-a vingt-cinq ans."

WE regret to announce the death, on the 14th inst., of Dr. H. B. Pollard, lecturer on biology and comparative anatomy at Charing Cross Hospital. Elected a scholar of Christ Church, Oxford, in 1885, Dr. Pollard graduated B.M. with first class honours in morphology in 1890, and concurrently gained similar distinction in the London intermediate and final B.Sc. examinations. He subsequently studied for two years under Prof. Wiedersheim at Freiburg, and in 1892 was appointed to the Oxford table at Dr. Dohrn's laboratory at Naples. In 1893 he was elected Berkeley Fellow of the Owens College, Manchester, and in 1895 lecturer at Charing Cross Hospital. He was granted the degree of D.Sc. by London University for a thesis on Polypterus. Dr. Pollard made a special study of fish, and in a series of papers contributed to German scientific periodicals, he originated a theory of their development which has received considerable attention from biologists. He was writing a text-book on the subject at the time of his death, which took place at Dover, in his twenty-eighth year. He was apparently stunned by a fall while bathing and drowned.

FOR the opening of museums and art galleries on Sundays we are undoubtedly very largely indebted to the zeal of Mr. Mark Judge, the Honorary Secretary of the Sunday Society. For some years the Society cried aloud in the wilderness, but few of the multitude paid heed, though such men as Darwin, Huxley, Romanes, Spottiswoode and Tyndall, only to mention a few of the supporters who are gone, became apostles of the movement. From the time when the Society was founded, thirty years ago, Mr. Judge has advanced its objects with the pertinacity which comes from conviction, and has thus educated public opinion on the subject of Sunday reform. The objects have now been attained, and there is a feeling that the services rendered by Mr. Judge in support of them should be publicly recognised. A Committee has therefore been formed to appeal, for subscriptions for a testimonial to Mr. Judge. It is hoped that a ready response will be made to the appeal, as a token of gratitude for the boon of Sunday opening. The Chairman of the Testimonial Committee is the Rev. S. A. Barnett, and the Hon. Sec. and Treasurer, Prof. Corfield, to whom subscriptions may be sent at 19 Savile Row, W.

WE learn from *Science* that the party from Cornell University which will embark with Lieut. Peary on the *Kite* is as follows. R. S. Tarr, professor of dynamic geology and physical geography; A. C. Gill, professor of mineralogy and petrography; J. A. Bonstell, assistant in geology; T. L. Watson, fellow in geology; E. M. Kindle, scholar in palæontology; and J. O. Martin, special student in entomology. It is the purpose of the party to make as thorough a geological study as is possible in five or six weeks, of the region near the Devil's Thumb, at the south end of Melville Bay, and in addition to this to make collections of flora and fauna. Another party will also sail with Lieutenant Peary, under the leadership of A. E. Burton, professor of civil engineering in the Massachusetts Institute of Technology. This party will land at the great Umanak Fiord; they will make pendulum observations, natural history collections, and study the glacial phenomena. Lieut. Peary himself will proceed north as far as Cape Sabine at the entrance of Smith Sound. He will also endeavour to explore Jones Sound. He will be accompanied by Mr. Albert Operti, the artist, who will take casts of the Cape York natives for the purpose of making models for the American Museum of Natural History, New York.

IN connection with the note in NATURE of June 18 (p. 158), with reference to the instruction in meteorology in the University of Odessa, our attention has been drawn to a circular relating to meteorological observations in schools, recently prepared for the Connecticut State Board of Education by Mr. R. De C. Ward, Instructor in Meteorology in Harvard University, and published by the Connecticut Board. The *Document* (No. 10, 1896) points out that the time has come when meteorology should be systematically taught in schools, and it indicates the lines along which the elementary study of the subject should proceed in order to be most thorough and useful. In addition to the registration of observations without the use of instruments, including current weather and the state of the sky, it is not proposed to attempt anything more than records of temperature, direction and force of wind, and rainfall during the early years of the grammar-school course. Such elementary work cannot fail to attract both teachers and scholars, and to lay a foundation on which, in after years, a more advanced study of meteorology (including the practical use of daily weather maps) may be built up.

THE Hawke's Bay Philosophical Institute, New Zealand, is fortunate in having such a generous and broad-minded friend as the Rev. William Colenso, F.R.S., as their President. At the opening of the Institute's session in May, after delivering an animated address, Mr. Colenso put before the meeting a scheme for the foundation of a museum to take the place of the present museum at Napier. He offered to give towards the realisation of his scheme the sum of £1000 and a freehold site, and to supplement this with a second donation of £500 so soon as £500 was given by some one else. The total amount required to establish the museum is about £4000. Referring to the conditions of gift, Mr. Colenso said: "The museum must be a building which will be open every day of the week and Sunday afternoons too. I find that this is the case in Auckland, where large numbers visit the museum on Sunday afternoons. And what better use can a man give to his time than in the observance of the wonderful works of his Maker? There is another proviso, and that is that the building must only be used for the purposes of a museum and library. There must be no concerts, no Liedertafels, no spouting, no mutual admiration societies, no globe-trotters, no tourists, and no parsons. I will not give a penny for persons of that kind. I have received a letter asking for assistance for a museum in my native town in England. There the money has to be raised by a certain time. So in Napier it must be raised by December 31. The deed would be vested in five trustees, who should be generous and businesslike men, with a keen interest in the project. The museum proposed would be a museum for the East Coast, not only for Hawke's Bay proper, or for the old provincial district, but for Poverty Bay and Gisborne and the country stretching up to the East Cape." There should be no difficulty in raising the money required for the consummation of the scheme which Mr. Colenso has in mind, and towards which he is willing to contribute so liberally.

Dr. Bruni, of Naples, has recently contributed an important paper to the *Annales de l'Institut Pasteur*, corroborating earlier investigations on the association of the typhoid bacillus with cases of osteomyelitis. The bacteriological study of this disease has recently been actively pursued, and a French physician not long ago published statistics of ninety cases in which he found the *Staphylococcus aureus* seventy times, and the typhoid bacillus four times. Particular interest attaches to the connection of Eberth's bacillus with osteomyelitis, since Orloff, Fränkel, and others have shown that this organism is frequently found in osseous tissue, whilst of especial importance is the discovery made by Chantemesse and Widal, that it has a particular predilection for the marrow of bones. Osteomyelitis may declare itself not only during the course of typhoid fever, or during the period of convalescence, but also a long time after the recovery has been completed. That a connection was possible between typhoid fever and subsequent manifestations of osteomyelitis was first indicated by Keen in 1878; but for the more precise information which is now at our disposal on this subject, we are indebted to Chantemesse and Widal. Dr. Bruni describes a most interesting case of osteomyelitis in which the typhoid bacillus was found in the marrow of the left tibia, six years after the patient had recovered from an acute attack of typhoid fever. Most careful tests were made, including Pfeiffer's ingenious serum reaction, to correctly diagnose the bacillus found as that of typhoid, and there appears to be no doubt that Dr. Bruni has furnished fresh evidence of the new *rôle* which may be assumed by this much-dreaded microbe.

During last year M. Flammarion made some interesting experiments as to the effect of lights of different colours upon vegetable growth (*Bull. Soc. Ast. France*, June). On July 4, eight identical sensitive plants, which had been sown at the same time, were selected for experiment. These were placed two by two in similarly constructed glass boxes, of which the sides were of different colours, one being red, one green, one blue, and another of ordinary clear class. All were exposed to precisely the same meteorological conditions throughout. The rates of growth were as follows:

	Red. m.	Green. m.	Blue. m.	White. m.
Sept. 6	0·220	0·090	0·027	0·045
,, 27	0.345	0·150	0·027	0 080
Oct. 22	0·420	0·152	0·027	0·100

Thus, while the plants exposed to blue light made no progress whatever, those exposed to red increased their height fifteen times. The latter, moreover, acquired an extraordinary degree of sensitiveness. Similar results, but not so strongly marked, were obtained with geraniums and other plants. The fact that the plants exposed to white light grew less rapidly than those which were under red glass, although receiving the same amount of red radiations, seems to suggest that the presence of blue light in the former case not only did not accelerate the growth of the plants, but actually retarded it.

In vol. viii. of the *Proc. Roy. Soc. Victoria* (Melbourne), recently published, Mr. R. Etheridge, jun., describes some Trilobite remains from Heathcote, on the western side of Mount Ida, which are of extreme interest as an addition to the scanty Cambrian fauna of the Antipodes. Although occurring only as casts, the characters of the head and pygidium appear to be clearly shown, so much so that Mr. C. D. Walcott, from an examination of careful drawings, unhesitatingly referred them to the Middle Cambrian. As the result of a critical comparison, Mr. Etheridge is unable to identify them with any known genus, and has named the specimens *Dinesus ida*. Along with this trilobite occurs a brachiopod, which seems very similar to *Lakhmina*, a form described from the Cambrian of the Salt Range, India. It is to be hoped that this scanty fauna, which is the only unquestionable *Middle* Cambrian fauna yet found in Australia, and which seems to have no close relation to any of the other Cambrian faunas of that country, may soon be added to, for it is certain that the trilobites are a most promising group for the determination of the geographical life-provinces which may have existed in these remote times. In the same volume there is a revision of (with additions to) the fauna of the Table Cape Beds, Tasmania, by Mr. Pritchard, who regards it as Eocene.

The *Agricultural Gazette* of Cape Colony publishes a letter sent by Sir Ferdinand von Mueller to Sir Hercules Robinson, the Governor of the Colony, and appealing for a reserve-ground for the preservation of rare Cape plants. As the veteran botanist of Victoria points out, the vegetation of South Africa is the richest in the world, not only as to number of species, but also as containing an astounding variety of plants of special and peculiar type, aggregated chiefly in the south-western provinces and occurring nowhere else. Hundreds of these are quite local and restricted to very circumscribed areas. They are sure to be swept out of existence altogether, unless special provision is made for their preservation; and it is on that account that the appeal is made for a wild-garden or reserve for the conservation of Cape plants in areas where they can be maintained for the knowledge of generations to come. It may be said that botanic gardens exist already in several parts of the colony; but in a report upon Baron von Mueller's proposal, Prof. Mac Owan remarks: "These places can only exist by making themselves into a lounge or pleasaunce of idle hours for the population living close by. I speak as one who knows, for it was my lot to run one of these for fourteen of the hardest and most unsatisfactory years of my working life. The conditions of support compelled the place to grovel down into a nursery-garden on commercial lines, in order to get money enough to keep it presentable for the daily stroller. Nor did I ever dare to plant up any single portion of it with typical representatives of our Flora. The public would have taken the alarm at once. They care nothing for the special prehistoric flora of the land they live in, compared with the newest hideous abortion in chrysanthemums. . . . So that some of the gardens which we complaisantly call botanic, have it in them to stand between the living and the dead, and stop the slow and sure extinction of the most ancient and interesting part of our Cape Flora. This state of things, brought home to me yearly as I traverse the same solitudes each season, and note the increasing scarcity of rare plants, has been much in mind; but I do not see any other way of dealing with the matter, than by the reserve, now recommended, of chosen localities for all time and inalienable." But much as this is to be desired, Prof. Mac Owan has to confess that the idea is not likely of even approximate fulfilment.

Under the editorship of Dr. Götz Martius, Professor of Philosophy in the University of Bonn, the first part of a new journal has appeared, entitled *Beiträge zur Psychologie und Philosophie*. The present number is devoted to considerations bearing on colour-vision, and contains three papers by Dr. Martius on the brightness of negative after-images, on a new method of determining the brightness of colours, and on the conception of specific brightness of colour-sensation. In addition to these, Herr Friedrich Kretzmann contributes a note on the brightness of complementary mixtures.

In *L'Elettricista*, Prof. A. Róiti describes a new tube for the production of Röntgen rays, in which the bottom end is covered with a cap of aluminium instead of glass, thus allowing freer passage of these rays. According to the figure given, it appears that this cap is used as the anode, the kathode being a concave speculum of aluminium facing it. By polishing with emery

the end of the tube over which the cap fits, the whole is made perfectly air-tight so that good vacua can be obtained. For taking photographs of bones, &c., none of the other tubes that the author had constructed or purchased approached anywhere near the present one in respect of intensity and sharpness of definition.

In the *Journal of Physiology*, Dr. Lazarus Barlow has pointed out that before the laws of osmosis, deduced from the final osmotic pressure, freezing point, &c., can be applied to the explanation of biological problems, it is necessary to determine whether the initial rates of osmosis of substances bear constant ratios to their final osmotic pressures, and whether the presence of proteid substances in the solutions affects the initial rate of osmosis. The author has found that the initial rates of osmosis cannot be determined from observations of the freezing points of solutions, and that proteid substances, even when present only in minute quantities, markedly diminish the rate of osmosis. In a subsequent paper, Dr. Barlow applies these conclusions to the consideration of lymph-formation, and describes observations of the specific gravity of the blood, of voluntary muscle, and of lymph, which have an important bearing on the question. In his conclusion the author summarises the evidence in favour of the occurrence of osmosis and increased filtration as the effective factors in causing the increased outflow of lymph that is seen after the injection of a crystalloid into the blood, as well as the evidence against the view that osmosis and increased filtration alone account for the observed phenomena.

A valuable little pamphlet on "Coal Mining," full of information on many questions of practical importance in the working and use of coal, has been received from Mr. W. Galloway. The pamphlet is an excerpt from the "Handbook of the Cardiff Exhibition," and may be obtained from the office of the *Western Mail*, Cardiff.

During the spring and summer, Herr P. Sintenis has been carrying out a botanical exploration of the mountains of the Peloponnesus. After visiting Volo in Thessaly, he proposes to investigate the almost unknown flora of the south-western portion of the Pindu Chain.

At the time of his death Mr. Seebohm had almost completed an exhaustive monograph on the "Family of Thrushes" We learn that Dr. Bowdler Sharpe has undertaken to finish the work, and that it will shortly be published by Messrs. Henry Sotheran and Co. It will be illustrated with nearly 150 coloured plates, and the edition will be limited to 250 copies.

A short account of the proceedings of the Sixth International Geographical Congress, held in London last July, appeared in these columns at the close of the Congress. The official Report, containing the addresses delivered and papers read before the Congress, together with a brief historical statement, has now been published. When it is remembered that the papers are in several languages, and that authors are often procrastinators in the matter of reading and returning proofs, the appearance of the Report within a year of the Congress is commendable. Most of the papers are of international interest, and all of them are of geographical value. The two Secretaries of the Congress, and Dr. Mill, who has done the editorial work in connection with the Report, are to be congratulated upon having brought their difficult tasks to a satisfactory conclusion.

The second edition of the valuable "Statistical Atlas of India" has been published by the Government of India, and is obtainable from Mr. Edward Stanford. The Atlas originally appeared in 1886, but since then another census of India has been taken, and new information has been obtained, so that a revision of the maps was necessary. The maps and diagrams in the Atlas give a good general idea of the character, inhabitants, and resources of India, and illustrate the commercial, financial, and educational condition of the country. Explanatory chapters are contributed by persons having special knowledge of the subjects of them; thus, Sir E. C. Buck writes on physical configuration, irrigation, famine, revenue and rent systems; Dr. W. King, on the geology of India; and Mr. J. Eliot, on the rainfall and climate. Mr. George Watt deals with crops and economic minerals; Mr. B. Ribbentrop with forests; Mr. J. E. O'Conor with prices, foreign trade, finance and taxation; and Veterinary-Lieutenant H. T. Pease with horses and live-stock. The Atlas is an excellent piece of work, which conveys by concise text and clear illustration, an abundance of information concerning our great Indian Empire.

The additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii*, ♂) from South Africa, presented by Mr. Vernon E. Barratt; a Black-eared Marmoset (*Hapale penicillata*) from South-east Brazil, presented by Mr. S. Osborn; two Golden Eagles (*Aquila chrysaetus*), two Peregrine Falcons (*Falco peregrinus*) from the Isle of Mull, presented by the Maclaine of Lochbuie; two Wood Owls (*Syrnium aluco*), a Short-eared Owl (*Asio brachyotus*), British, presented by Mr. A. Farquahar Wilson; a Ring-necked Parrakeet (*Palæornis torquatus*) from India, presented by Miss Smith; a Black-headed Conure (*Conurus nanday*) from Paraguay, presented by Mrs. Baird; two Peafowls (*Pavo cristatus, albino*) from the Transvaal, presented by Mr. F. A. Noyce; a Mona Monkey (*Cercopithecus mona*), two West-African Love-Birds (*Agapornis pullaria*) from West Africa, a Crab-eating Raccoon (*Procyon cancrivorus*) from South America, deposited; an Australian Fruit Bat (*Pteropus poliocephalus*) from Australia, purchased; a Burrhel Wild Sheep (*Ovis burrhel*), a Thar (*Capra jemlaica*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

Return of Comet Brooks (1889 V.).—A telegram from Kiel announces that Brooks's periodic comet was observed by Javelle at Nice on June 20. At 14h. 17·4m. mean time it was in R.A. 22h. 25m. 30s., Decl. 18° 33′ 59″ S. The comet is now in the southern part of Aquarius, and rises about midnight. It is interesting to note that the observed place of the comet shows a very close agreement with Dr. Bauschinger's search ephemeris printed in Nature (vol. liv. p. 84).

Visibility of Solar Prominences.—Prof. Hale has brought together some facts which emphasise the importance of the work which may be done by observers of solar prominences at the time of a total solar eclipse without going to view the eclipse itself (*Astrophys. Jour.*, May). It is pointed out that in 1870 Tacchini concluded that the dimensions of prominences spectroscopically observed in full sunshine, and measured in Hα light, were considerably smaller than those measured telescopically during an eclipse. In 1883 the same observer discovered the "white prominences," and found that these were not visible in the spectroscope immediately after the eclipse. Similar results were obtained in 1886, and it was further ascertained that the spectrum of a white prominence consisted principally of the H and K lines, the hydrogen lines being extremely feeble.

The results obtained during the eclipse of 1893 furnish valuable data as to the relative efficiency of the different methods of registering the forms of the prominences, as the spectroheliograph at Chicago was employed on that occasion, and a complete set of eye observations was secured by Fenyi at Kalocsa. A comparison is drawn between these non-eclipse observations and the forms of the prominences as photographed nearly at the same time by Prof. Schaeberle, in Chili, and by Mr. Fowler with the prismatic camera in Af ca. It turns out that one of

the largest prominences depicted in all the photographs was not seen at all at Kalocsa. The results with the spectroheliograph were not of the best, owing to haze; but from all available facts, it seems to be established that the white prominences are spectroscopically invisible because they shine chiefly by H and K light. Nevertheless, light of the same refrangibility in the electric arc undoubtedly appears violet; but it may be, as Prof. Hale suggests, that the violet tinge is overlooked in the presence of the more conspicuous colours during an eclipse. The best results obtainable with the spectroheliograph, when K light is utilised, compare very favourably in sharpness of definition, as well as in the rendering of faint details, with the best photographs taken during an eclipse.

SHOOTING-STAR RADIANTS.—In connection with a table of radiant points observed at Hong Kong, Dr. Doberck refers to several interesting points relating to the phenomena of shooting-stars (*Ast. Nach.*, 3360). It is pointed out that the long continuance of some of the radiants is accounted for by parabolic motion, while others can possibly be explained by hyperbolic motion. In explanation of some of the radiants having somewhat similar elements, it is suggested that they were possibly associated with different tails of the same comet.

Owing to the fact that the meteorites are heated to incandescence nearer the earth in the evening than in the morning, there is a small decrease in the average magnitude of shooting-stars during the night; before 9 p.m. the average brightness is mag. 2·7, while of those seen later it is 3·2. Again, on account of the earth's movement, the duration decreases from 0·9 sec. between 6 and 8 p.m. to 0·5 sec. between 8 and 11 p.m., and to 0·3 sec. between 11 p.m. and 4 a.m. Up to 11 p.m. the mean length of path is 15°, and afterwards 13°. The average duration, length, angular velocity per second, and the numbers of shooting-stars observed, classified according to magnitude, are shown in the following table:—

Mag.	Duration. s.	Length. °	Velocity. °	Number.
1	0·9	19	21	60
2	0·4	14	35	79
3	0·3	13	43	130
4	0·3	12	40	128
5	0·2	12	60	97

The majority of the shooting-stars below third magnitude were probably hidden by haze and artificial light.

KEPLER AND HIS WORK.—In a little pamphlet entitled "Kepler's Lehre von der Gravitation" (Halle, Max Niemeyer), Dr. Ernst Goldbeck gives an interesting and appreciative account of Kepler and his work. The point principally elaborated is a main difference between Kepler's methods and those pursued by Ptolemy and the older astronomers. These latter were content to solve the problem of celestial mechanics on purely mathematical lines. They were instructed in the shape of the orbits and their dependence on time; they could foretell the place of an object at a definite epoch, and this satisfied their astronomical needs. Kepler, however, the forerunner of the modern school, is concerned in the character and the operation of the force, on which these motions depend. The points surveyed by the author as affecting the development of Kepler's views in his approach to a gravitational theory of the earth are: (1) The transference of the centre of the solar system from the earth to the sun, and the consequent disturbance of Aristotle's views. (2) The impetus given to mechanical inquiry by Gilbert's magnetical investigations. (3) The discovery of the coincidence of tidal phenomena with the position of the moon, and consequently the suggested attraction. (4) The telescopic examination of the moon by Galileo, and the confirmation of the suspected identity of its general character with that of the earth. Kepler's work on Mars, and his endeavours to trace the nature of the connection between the sun and the planets, are graphically described, and the whole pamphlet well repays careful study.

SCIENCE AND SOCIETY AT THE CENTRAL TECHNICAL COLLEGE.

THE object of the conversazione at the Central Technical College, Exhibition Road, on Friday, June 12, was to enable the scientific public to witness the ordinary working life of the students there. Consequently, while in deference to the lady visitors, the staircases and corridors were rendered attractive with arches of palms, arm-chairs, arc lights, and Hungarian airs, neither the blossoms, the banners, nor the band, were allowed to intrude on the apparatus and machinery, which were left as in every-day use.

Laboratory sinks remained sinks, and were not converted into make-believe flower-boxes; while no green baize covers hid the traces of oil and tools on the workshop benches, nor made them resemble extemporised billiard tables.

The Lord Chancellor, as Chairman of Council, and Lady Halsbury, received the visitors, and conspicuous amongst the 1700 were the Masters of many of the City Companies wearing their chains of office.

Exactly twelve years ago to-day (June 25, 1896) the Central Technical College was opened by the Prince of Wales, who expressed the opinion, "that the opportunities for advanced instruction, which will be afforded in the well-arranged laboratories and workshops, will enable the managers and superintendents of our manufacturing works to obtain more readily than hitherto the higher technical instruction which is so essential to the development of our trade and commerce." And, on the same occasion, the late Lord Selborne—the then Lord Chancellor—stated that "in the several laboratories with which this College is provided, new and increased facilities will be afforded for the prosecution of original research, having for its object the more thorough training of the students, and the elucidation of the theory of industrial processes."

An examination of the laboratories and workshops by the visitors at the conversazione, made it clear that the aims initially laid down for the working of the Central Technical College have been steadily kept in view. The Department of Mechanics and Mathematics showed the apparatus which had been developed for familiarising students with the laws of motion and force. Electric clocks transmit time-signals to quick-running Morse instruments for chronographically marking the instants of various experimental events. To measure "g" the falling body is started electrically, its moment of arrival noted electrically, and the interval measured with a vibrating tuning-fork; while for slower motions, such as that of a body rolling down an inclined plane, the electric current that liberates the ball starts a stream of water flowing from a water-clock, which again is instantly stopped on the ball touching an electric trigger placed at any desired point of its path. Apparatus for measuring centrifugal forces, studying impact, finding moments of inertia, timing the vibrations of pendulums, measuring the extensions of wire, &c., make us wish that, when, as boys thirty or forty years ago, we laboured through "little Newth," acquired a particle of Tait and Steele, and struggled with the rigidity of Routh's Dynamics, some Maxwellian demon had opened the door of Prof. Henrici's laboratory, and shown us so vivid a realisation of the principles of what, in the misleading jargon of that day, was called "statics and dynamics," with its "accelerating forces" and "moving forces."

In the same department were seen calculating machines and quadric surfaces, planimeters and plaster of Paris models, integraphs for solving differential equations, and integrators for evaluating areas; while the smooth working of the latest form of Prof. Henrici's harmonic analyser, by means of which ten coefficients in a Fourier's series can be determined by going only once over a curve, led the engineer to speculate on the time when all calculations, however complex, would be done by turning a handle, and when the brain would be left quite free to think and originate.

So much attention has of late been given by School Boards and County Councils to the establishment of manual training classes, that the collection of exercises in wood-working in the Carpenter's Shop of the Engineering Department, could not fail to attract attention. But more attractive still was the laboratory for testing materials, where the deliberate motion of the lever of the 100-ton machine, stretching steel plates until they broke, and automatically writing the history of the experiment with Prof. Unwin's stress-strain-recorder, was as fascinating to the lady-visitors as to the engineers who accompanied them. And how complete is the investigation that the students can make on the properties of the materials used by the engineer and builder, could be gathered from seeing the smaller machines which were bending thick beams of wood, stretching wires, and breaking blocks of cement, as well as from examining those specially designed for testing lubricants, gauges, and the elastic constants of materials, such as the screw and mirror extensometers and compressometers designed by Prof. Unwin.

The desire of every lad to make something is gratified and educationally directed in the Engineering Workshop, which is liberally fitted with milling, planing, shaping, and slotting machines, and four of the lathes, we were told, had been made by the students themselves, while one weighing three tons, and having a 10-foot gap bed, we saw in process of construction.

The economy of a De Lavel steam turbine, running at 32,000 revolutions a minute, and of a Tower spherical engine, were being tested in the Steam Laboratory, while a 40-horse power condensing engine, specially designed to illustrate the effect of varying the conditions of working, has fitted to it a very satisfactory hand-brake, indicator gear, and arrangements for measuring the circulating water, the condensed steam, the jacket and receiver drainage, &c. And, as a memento of the improvements that can be effected in prime movers by experimental inquiry, there stands the very engine used by the late Mr. Willans in his classical investigations on steam engine economy, cut through so as to expose a sectional view of the cylinders, pistons, and valves.

Adjoining the Steam Laboratory is the boiler-room, where in addition to the Lancashire and Cornish boilers, used for generating steam for the engines, is a Babcock and Wilcox boiler, used exclusively for boiler and fuel tests, with its accompaniments of feed-water measuring tanks, coal-weighing apparatus, dasymeter for determining the percentage of carbonic acid in the furnace gases, &c.

In the laboratories of the Physical Department are many instruments and pieces of apparatus that have been developed there, and specimens of which are now to be found in other colleges, electrical works, and electric lighting stations. In the dynamo room are speed cones by means of which the speed of any dynamo can be varied between wide limits, and, what is equally important for experimental purposes, can be kept at a constant value independently of variations in the speed of the engine, or in the amount of slip of a belt when it is transmitting different amounts of power. Doubts were originally expressed as to the possibility of such cones being used to transmit even 10-horse power satisfactorily, but their successful working having been proved, sets of them were reproduced for University College, Nottingham, the McGill University, Montreal, &c. This room contains many different types of dynamos, and, as space is limited, one is driven with a weighted pulley hanging in a very short belt passing over the fly-wheel of the engine, the dynamo itself being balanced on trunions, so that it turns on an axis at right angles to that round which the armature rotates.

The "injector" for producing any desired shape of wave, and so enabling one alternating current dynamo to serve the purpose of many, was shown in use, and the vibrating wire curve tracer, described at the last meeting of the British Association, was writing out the wave-forms so produced. The permeability of iron rods was being examined with the small dynamo recently shown at the Royal Society's soirée, and the regulation of transformers differentially tested with an electrostatic voltmeter, with which a pressure of one volt can be measured without any independent electrification.

Those interested in the bills sent in by Electric Light Companies had an opportunity of seeing American, English, French and German electric supply meters being tested at various temperatures in the Magnetic Research Laboratory, as well as experiments on the slow rise of temperature in underground electric mains.

The Electrical Research Laboratories contain various forms of electrostatic voltmeters, some of which were being tried, while others were in use for measuring the electric pressure at which cables and insulating oils break down by sparking. A Lorenz apparatus for the determination of the ohm, which had been constructed regardless of cost for the M'Gill University, and sent to the college to be tested, attracted much attention. It is certainly unique in its details, and eminently characteristic of the transatlantic millionaire who stipulates that the wealth which he showers on the laboratory named after him shall be used to purchase only the "very best apparatus." How many an English professor would delight in having such a condition imposed by a benefactor determined that the laboratory founded by him should be the most costly in the world.

In another room was a secohmmeter spinning out coefficients of self-induction, a new addition to the Wheatstone's bridge for facilitating the measurement of very small resistances, and an artificial submarine cable, electrically as long as those under the Atlantic, with which the retardation in the passage of the telegraphic signals was demonstrated to the visitors.

In the Arc Lamp Laboratories the photometry of the arc, and the steady feeding of the carbons with various types of lamps, were shown, also the details of the experimental lamp used in the recently published researches was explained. The observer sees close to him the arc itself and its image enlarged ten times, also the spots of light indicating the current flowing and the potential difference maintained between the carbons; while in front of him are handles for regulating the current, the position of each carbon, &c. Mark Tapley would doubtless have said that there was no credit in making discoveries under *such* circumstances.

On a screen on a wall the voltmeter and ammeter spots of another arc were seen dancing up and down, and proving that when an alternating current is superimposed on a direct current arc the oscillations of potential difference and current are in the same direction when the carbons are cored, but in opposite directions when they are solid.

Gas-burners and glow-lamp testing, polarimetry, and spectrophotometry are carried out in the Senior Optical Laboratory, and the curves of results obtained by the students showed the most economical gas pressure to use with each type of burner; why it pays the gas companies to make the gas flare and the private consumer to use governed burners, and how much dearer, as far as mere light is concerned, is glow-lamp lighting than gas lighting with the Welsbach burners.

A range of rooms on the first floor is devoted to the Junior Physical Laboratories, and in them students, who frequently have never worked in a laboratory before, learn the principles of electricity, heat, light, magnetism and sound by performing an organised series of quantitative physical exercises.

In both the Physical and Chemical Departments there were several exhibits of "seeing with X-rays," the potassium-platino cyanide screens, which have been so successfully constructed by Mr. Jackson, being lent for the occasion. The majority of the exhibits, however, in the Chemical Department were connected with the educational methods employed, and with the results which have been obtained from the researches carried out by the advanced students and the staff. Prof. Armstrong has long advocated that every student of chemistry should be early infused with the spirit of scientific inquiry; and that this principle has been practised in his laboratories, and not merely preached in his lecture-room, was proved by the large number of specimens of new series of compounds which were exhibited as the outcome of the work in his department. Sulphuric derivatives of camphor prepared for the first time in a pure state, hundreds of specimens of derivatives of naphthalene—the hydrocarbon from which so many modern dye-stuffs are made—obtained experimentally, and the apparatus for many researches in course of progress, attracted attention.

In the Junior Chemical Laboratory were exhibited the apparatus and experiments used in connection with the courses to teachers that have been given at the College. This apparatus is suitable for the use of teachers giving elementary instruction in technical schools, as well as for carrying out the experiments recommended in the syllabus of elementary science (chemistry and physics) issued by the Incorporated Association of Headmasters.

For the last ten years Dr. Armstrong has made strenuous efforts to obtain adequate recognition for that hitherto much neglected, but all important branch of physical chemistry, crystallography, and in consequence the crystallographic branch of the department has gradually extended in size, until at present the laboratory devoted to that subject rivals the best on the continent for completeness of equipment. Numerous measurements and drawings of crystals that had been made by the students were exhibited, and demonstrations of the methods employed in the optical examination of crystals were given in the adjoining lecture theatre during the evening, apparatus that had been specially devised to facilitate the accurate examination of doubly refracting substances being employed for the purpose.

In the Woodcarving Department, under the direction of Miss Rowe, there was an exhibition of carving in a variety of styles by present and past students, some of the latter being now the instructors in this and in other schools of art woodcarving. A renaissance panel illustrative of the arts of sculpture, architecture, and literature, an Italian bracket, and a pediment for a bookcase, a low relief renaissance frieze, &c., showed boldness and finish, while the practical demonstrations of the different

methods of working in high and low relief attracted much attention.

What is the outcome of it all, thought the visitor, as he left with his mind whirling with slotting machines, scalar quantities, secohmmeters, and sugar analysis? Has original research been prosecuted as foreshadowed by Lord Selborne? Where are the some 200 students that have been awarded the diploma of Associateship of the Institute, and all the other special students who have passed through courses at the Central Technical College? The seventy papers communicated by the students, and the staff, to the proceedings of various scientific societies answer the first question, while the reports issued yearly by the Dean give information on the second point; some of the past students are the Principals, and some have charge of departments at technical schools; some are the chief engineers and some assistant engineers at electric light central stations in England; some hold postsin chemical works, and some are railway engineers, and others telegraph engineers in India, but practically all appear to be employed. And what is a little remarkable—in view of the vast number of people who have been attracted to follow engineering pursuits during the past few years—we understand that nearly all the students who have passed through the Central Technical College are in receipt of pay for the services they are rendering, and are not paying premiums to employers for the privilege of being allowed to do hard work.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following is the speech delivered by the Public Orator, Dr. Sandys, in presenting for the honorary degree of Doctor in Science Prof. Newcomb, of Johns Hopkins University, Superintendent of the American Nautical Almanac.

Si Thales ille Milesius, "rerum naturae certissimus explorator et astrorum peritissimus contemplator," sapiens propterea nominatus est, quod solem lunae oppositu solere deficere primus omnium vidisse fertur, etiam hunc virum sapientiae laude non indignum arbitramur, qui solis et lunae defectus omnes antiquitus observatos cum astronomiae legibus hodiernis accuratissime comparavit. Idem quanto ingenii acumine aliorum de lunae motu placita correxit; quam admirabili studiorum caelestium cognatione cum Neptuni inventore nostro consociatus est; quam infinita denique cura fratribus nostris transmarinis trans aequora navigantibus siderum cursus litterarum monumentis mandatos explicavit. Talium virorum de genere humano merita dum contemplamur, non iam miramur ipsum Vergilium a Musis esse precatum, ut sibi ante omnia

"caelique vias et sidera monstrent,
defectus solis varios lunaeque labores."

Duco ad vos astronomum illustrem, SIMONEM NEWCOMB.

At the annual election, on June 22, at St. John's College, the Hutchinson Studentship was awarded to A. S. Hemmy, double first in Natural Sciences, for research in Physical Chemistry. Foundation Scholarships, varying in value from £100 to £50 a year, were given to the following Science Students:—K. C. Browning, D. J. Morgan, J. S. White, N. B. Harman, J. H. Howitt; and Exhibitions in Natural Science to J. A. Glover, R. F. C. Ward, A. C. Ingram, Jehu, and Yapp. In Mechanical Sciences and Engineering, Foundation Scholarships were for the first time awarded to W. S. La Trobe (£80) and A. Chapple (£50). It is noteworthy that Messrs. Hemmy, La Trobe, and Chapple, who have thus carried off the chief scientific honours, are all colonial graduates, from the Universities of Melbourne, New Zealand, and Adelaide, respectively. Mr. J. E. de Villiers, of this College, who takes the highest honours in Law, being senior in his Tripos Part I., is a graduate of the Cape of Good Hope.

The Harkness Scholarship in Geology and Palæontology is awarded to J. H. Gray, Scholar of King's College.

In Part I. of the Natural Sciences Tripos, thirty men are placed in the first class; in Part II. eleven men attain this distinction. No woman gains a first class in either part.

SESQUICENTENNIAL gifts continue to pour in upon Princeton University. An unnamed benefactor has given funds for a new library building.

THE following are among recent appointments:—Dr. Theodor Des Coudres to be Extraordinary Professor of Physics in Gottingen University, and Dr. Otto Bürger to be Extraordinary Professor of Zoology; Mr. A. A. Heller to be Instructor in Plant Taxonomy at the University of Minnesota, and Curator of the University Herbarium.

THE fitness of Convocation of the University of London to deal with such subjects as a Teaching University may be estimated from the result of the meeting held on Tuesday. The chief business was the election of a Fellow of the University, and the following gentlemen had been nominated:—Sir Joseph Lister, Mr. Walter Rivington, and Mr. Richard Mosey Stephenson. The election was one in which voting papers were permissible, and the result of the counting of the votes was that Mr. Rivington obtained 963, and Sir Joseph Lister only 846 votes.

THE report of the Technical Education Committee which was adopted at the meeting of the Devonshire County Council, held at Exeter on the 11th inst., shows that the work done on the agricultural side of Ashburton Grammar School is of so satisfactory a nature that an additional grant has been awarded to the school; also that 175 continuation schools have been maintained throughout the year. At the same meeting the following resolution was passed by a substantial majority:—"That this Council, while offering at present no opinion as to the advisability or otherwise of placing secondary education under the control of the local education authority, strongly deprecates the proposal to transfer to them any duties connected with elementary education."

A SPECIAL Committee, appointed by the West Riding County Council to watch the Education Bill, have passed the following resolution:—"That in view of the amendment to the Education Bill, 1896, whereby every non-county borough with a population of 20,000 is to appoint an Education Committee, amendments should be introduced by way of limiting the duties of the education authority of such a borough to such defined matters as may be least hurtful to the administrative county, and the cause of education."

A MEETING of the Executive Council of the County Councils Association was held on Friday morning last, at the Guildhall, Westminster. Lord Thring having briefly explained the circumstances under which the meeting had been convened, it was proposed by Lord E. Fitzmaurice, and seconded by Sir J. E. Dorington, Bart., M.P., and resolved:—"That this Council, considering the changes which have been introduced into the constitution of the education authority by the exclusion from the administrative county of non-county boroughs with a population of 20,000, is of opinion that the above change strikes a serious blow at the administration of the Technical Education Acts, and of county administration generally." It was also resolved that the Parliamentary Committee be authorised to arrange for the presentation of the foregoing resolution to the Right Hon. A. J. Balfour, M.P., and His Grace the Duke of Devonshire.

THE Education Bill has been abandoned by the Government, and the eleven days of Parliamentary time spent in discussing it have been sacrificed. It is proposed to bring up the subject afresh next January, but there is little possibility that the measure which will then be brought forward will be of the very contentious character of the one just withdrawn.

THE National Home Reading Union aims mainly to make high-class reading attractive, and to give advice with regard to courses of reading in romance, travel, biography, economics, ancient and modern history, English and foreign literatures, science and art. Once a year it is the custom of the Union to hold a summer assembly at some interesting centre, when lectures are given in connection with the courses of study which have been pursued during the past winter. This year Chester has been chosen, and the assembly takes place there between June 27 and July 6. But not only will the subjects recently studied claim attention, for there will be several lectures on the botany, geology, and architecture of the district, besides a lecture by Mr. St. John Hope on "The Arrangements of Mediæval Monasteries," with special reference to Chester. A number of interesting excursions and social gatherings have been arranged, including a visit to Northwich to descend a salt mine.

THE Technical Education Board of the London County Council next month will appoint not more than five Senior County Scholars. Each scholarship will be tenable for three years, and of the annual value of £60, together with free instruction in a college of university rank, provided that the fees

do not exceed £30 a year. In the case of scholars proceeding to the old universities a contribution of £30 per annum is made by the Board towards the college and university tuition fees. Candidates must be resident within the administrative County of London, and must send in applications to the Secretary of the Board, at 13 Spring Gardens, on or before Monday, June 29, on forms which can be obtained on application. Last year the Board awarded several exhibitions of smaller value to specially deserving candidates in addition to appointing five County Scholars. Hitherto the selection of the scholars has been based upon the record of their past achievements and testimonials received from their teachers or others qualified to judge of their capabilities. These scholarships are restricted to candidates whose parents are in receipt of not more than £400 per annum.

THE Hartley Institution at Southampton has not developed so much as it might have done since it was established, owing to a divided management and limited finances, but it has now entered upon a brighter part of its career, and we confidently expect to learn of rapid and vigorous growth in the near future. The Secretary of the Institution has retired on a pension, and the Town Council of Southampton have decided to grant a farthing rate for one year to the Hartley Council. The action of the Borough Council in giving rate aid in support of technical and scientific education, in addition to the whole of the residue under the Customs and Excise Act, shows that the friends of educational advancement upon the Council are strong enough to make headway in spite of contrary breezes. Dr. R. W. Stewart, the Principal, is now free to develop his well-laid schemes for extending and improving the work of the Hartley Institution, and there is every reason for believing that under his whole management, and with the increased resources now available, the Institution will extend in the right direction, while at the same time the position of Southampton as an educational centre will be advanced. The objects of the proposed reorganisation are, first, the extension of the evening technical classes, and, second, a complete change in the work of the day classes. The extension of the evening classes will take place mainly in improving and extending the trade and commercial classes, and in providing classes for teachers. It was to make these changes that a farthing rate was solicited. The help was asked not to relieve the Hartley Council of any present financial embarrassment, but to enable them to carry out a scheme of educational reform which must ultimately be of the greatest benefit to the town and neighbourhood. A few of the reasons which showed the necessity for reorganising the educational work of the Institution may be specified. The Institution is already provided with buildings, and during the last five years the accommodation and equipment had been greatly improved by the provision of new lecture-rooms, a chemical laboratory, a physical laboratory, and engineering and other workshops. All this would be practically wasted and lost to the town unless supplemented by the appointment of a properly qualified teaching staff, able to utilise and develop the resources of the Institution to the utmost. The income of the Institution—about £2750—was not quite enough to meet the general working expenses and to provide a staff of this kind; but with the grant now made by the Town Council a much more efficient return will be obtained. The development of the Institution on the lines suggested will enable students to obtain an education of university rank, and to proceed to a degree in arts, or science, or law, at the Uinversity of London, by attending a three years' course at the day classes of the Institution in their own town. Lecturers are to be appointed in mathematics, biology and geology, English and classics, French and German, at a salary of £150 per annum each. This is something for Southampton to be proud of, and we trust that the policy which has inaugurated the new epoch in the educational history of the town will permanently represent the feeling of the Borough Council.

SCIENTIFIC SERIALS.

American Journal of Science, June.—On the colour relations of atoms, ions, and molecules, by M. Carey Lea. Part II. If a coloured substance be formed by the union of a colourless kation with a colourless anion, the colour belongs to the molecule only. Consequently, if we find a solvent which, like water, is capable of separating the ions, the resultant solution when dilute must be colourless, no matter how intense the colour of the compound. Experiments confirm this law without exception. Antimony pentasulphide, a strongly coloured compound, is a case in point. When dissolved in an alkaline sulphide, the ions of antimony and sulphur, themselves colourless, separate sufficiently to no longer change each other's vibration periods. They still, however, remain within the sphere of mutual influence. The union of coloured and colourless ions gives rise to the most surprising changes of colour. Two similar coloured ions may unite to form a colourless element. Two similar colourless ions may unite to form a strongly-coloured element. No black ion is known. There is absolutely no relation traceable between the colour of an ion and that of the element which it aids to form.—The gravimetric determination of selenium, by A. W. Peirce. The usual method used in the gravimetric determination of selenious acid, that of precipitating the selenium with sulphurous acid in presence of hydrochloric acid, is slow and incomplete. The author substitutes potassium iodide for the sulphurous acid. To avoid obtaining the selenium in the pasty condition when large quantities are present, the potassium iodide should be considerably in excess of the amount necessary for precipitation.—The extinct *Felidæ* of North America, by G. I. Adams. This is an attempt to give a general account of this family, to summarise the literature on the subject, and to work out a comprehensive classification. The paper is accompanied by three admirable plates.—The age of the igneous rocks of the Yellowstone National Park, by Arnold Hague. The pouring out of igneous rocks began with the post-Laramie uplift, or closely followed it, and from the time of the first appearance of these rocks, volcanic eruptions continued throughout Tertiary time.—Researches on the Röntgen rays, by Alfred M. Mayer. Herapathite, an iodosulphate of quinine, the most powerfully polarising substance known, is incapable of polarising X-rays. The actinic effect of X-rays varies inversely as the square of the distance of the sensitive plate from the radiant source.—On the *Pithecanthropus erectus*, from the Tertiary of Java, by O. C. Marsh. It may be taken as established that the remains of this "missing link" at present known are of Pliocene age. The tooth, skull, and femur found belonged to the same individual. This individual was not human, but represented a form intermediate between man and the higher apes.

Wiedemann's Annalen der Physik und Chemie, No. 5.—Anomalous electric dispersion of liquids, by P. Drude. Short electric waves (of 70 cm wave-length in air) are more strongly damped in alcohol, and especially in glycerine, than in water or in aqueous solutions. Theoretically, the damping should increase with the conductivity. But these badly conducting bodies are found to damp electric waves as effectually as a 5 per cent. solution of copper sulphate, which is 6000 times more conducting. This is not the only anomaly exhibited by ethyl and amyl alcohol, glycerine, and acetic acid. They also show anomalous dispersion for rapid electric oscillations, *i.e.* a decrease of the electric index of refraction with increasing frequency. Further, the specific inductive capacities are greater than the squares of the electric indices of refraction. Water, methyl alcohol, and benzol show no such anomalies, and ether only shows anomalous absorption.—Thermo-couples of amalgams and electrolytes, by A. Hagenbach. These were prepared by connecting two beakers filled with an amalgam by means of an M-shaped siphon filled with an aqueous solution of a salt of the same metal, the ends of the siphon being closed by a membrane. The amalgams were enclosed in water baths, and could be heated simultaneously or alternately. The only metals suitable for accurate measurements were cadmium and lead. Theory demands that as the salt solutions are diluted the thermo-electric forces shall increase. This law was found to fail with the divalent elements named. A couple, consisting of cadmium amalgam and cadmium chloride or nitrate, showed a steady diminution of the thermo-electric force as dilution increased from 0·1 to 0·0001 of the normal.—Contributions to the knowledge of fluorescence, by G. C. Schmidt. The author maintains that all bodies are capable of fluorescence if dissolved in suitable solvents. The most favourable form in which a substance may occur is that of a "solid solution." Aniline dyes may be made to fluoresce by solution in sugar, gelatine, hippuric acid, quinine bisulphate, and other substances. The colour of fluorescence is often nearly independent of the solvent.—Theoretical investigations concerning light, by P. Glan. The author calculates the absorption of various substances for a certain kind of ultra-violet light from their thermal conductivities and refractive indices, and shows that muscle, horn, wood, bone, cork, paper,

ebonite, shellac, lampblack, water, and carbon bisulphide must behave towards these rays in the same manner as they have been found to behave towards Röntgen rays.—A new form of mercurial air-pump, and the preservation of the vacuum in Röntgen tubes, by R. W. Wood. The author describes a simple pump consisting of a system of tubes and bulbs containing the vacuum tube in one branch. It is completely closed, and the vacuum is restored at will by simply oscillating the whole apparatus.

Bulletin de la Société des Naturalistes de Moscou, 1895, No. 2.—Contributions to the knowledge of the molecular forces, as a foundation to thermodynamics, by J. Weinberg; fourth part, dealing with capillarity and adhesion.—The development of the occipital region of the lower verterbrates, in connection with the question of metamery of the head, by A. Sewertsoff. An elaborate and suggestive work, in German, with two plates.—On the rotation of the earth, supposed to be fluid in its interior, by Th. Sloudsky, in French.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 4.—"Observations on Atmospheric Electricity at the Kew Observatory." By Dr. C. Chree.

The primary object of the investigation was to arrive at a more exact interpretation of the records obtained with the Kew electrograph, and to devise improvements in the conditions under which it works. The electrograph curves are intended to give the value of the potential at the point in the air where a water jet issuing from a long pipe breaks into drops. The proximity of a tall building has naturally, however, a large influence on the potential, so that no direct estimate could be made of the true potential gradient, *i.e.* the increase in potential per unit of height in the open.

Some preliminary experiments were made, which may be regarded as verifying Prof. Exner's experimental conclusion that a building under normal conditions reduces the potential in its neighbourhood, as if it formed an integral part of the earth's surface. Subsequently four series of observations were made. The respective seasons were November–December, 1894, March–April, June–July, and October–November, 1895. The observations were taken with a portable electrometer of known scale value, at one or two approximately constant hours, at five or six stations on or near the Observatory.

The results were consistent with the view that such general phenomena as diurnal or annual variation of potential got out with the same instrument at the several stations would show a good agreement.

A comparison was also made between the potentials deduced from the electrograph curves and the readings of the portable electrometer.

The values of the several meteorological elements, at the times of the observations with the portable electrometer, were derived from the Observatory records.

They afforded the opportunity of carrying out a searching investigation into possible connections of the several meteorological elements and the potential gradient. Attention was particularly directed to data bearing on Exner's theory, which connects potential gradient with density of aqueous vapour through a definite formula, departures from which are to be regarded as abnormal and due to disturbing causes. Special attention was also devoted to the possible influence of bright sunshine in reducing the potential gradient, in consequence of the theory proposed by Elster and Geitel.

The results of the investigation seem far from favourable to Exner's hypothesis. They afford a certain amount of general support to Elster and Geitel's theory, inasmuch as on an average potential seemed lower after long previous sunshine. The evidence, however, in favour of a connection between high potential and low temperature, high barometric pressure, low wind velocity, and anti-cyclonic conditions generally, seems about equally strong with that in favour of Elster and Geitel's theory. In each case notable exceptions appeared to any general rule.

Chemical Society, May 28.—Mr. A. G. V. Harcourt, President, in the chair.—Prof. P. P. Bedson delivered the Lothar Meyer Memorial Lecture. The lecturer reviewed Meyer's contributions to our knowledge of the gases contained in the blood and of the periodic law, and gave an account of the work done by the late German chemist towards promoting the systematic arrangement of inorganic chemistry, pointing out how great had been Meyer's influence on the promotion and advancement of chemical theory during the past thirty years.

June 4.—Mr. A. G. V. Harcourt, President, in the chair.—It was announced that an address is to be presented to Prof. Cannizzaro on the occasion of his seventieth birthday in July next; an address is also being presented to Lord Kelvin on the completion of his fiftieth year as Professor of Natural Philosophy in Glasgow University. The following papers were read:—On magnetic rotatory power, especially of aromatic compounds, by W. H. Perkin. The author describes apparatus used for determining magnetic rotations, and having determined the influence of temperature and dissolution on this property, gives the results of the examination of a large number of compounds of different types. Great differences exist between the magnetic rotations of aromatic and fatty compounds, the nuclei contained in a substance considerably influencing its rotation; frequently the compounds behave as composite molecules, the fatty and cyclic part separately influencing the magnetic rotation; the presence of a carbonyl group connecting the nucleal and fatty groups seems to act as a screen, preventing them from influencing each other. The influence of the nucleus on the rotation is reduced by the presence of electro-negative groups, and increased by that of electro-positive ones; this great liability of the magnetic rotation of the nucleus to change, is connected with the fact of its unsaturatedness, for saturated cyclic compounds behave like ordinary open chains. The so-called values given for atomic refractions or magnetic rotations are not true physical constants, but are merely the average influences which elements or radicles exert in different compounds; this, however, does not detract from their usefulness in determining constitution.—Mononitroguaiacol, by R. Meldola. One mononitro-derivative, probably the para-compound, is obtained by nitrating acetylguaiacol; benzoylguaiacol yields two mononitro-derivatives, probably the ortho- and para-, on nitration. Mononitroguaiacol may be prepared by hydrolysing its acetyl-derivative.

Linnean Society, June 4.—Anniversary Meeting.—Mr. C. B. Clarke, F.R.S., President, in the chair.—The Gold Medal of the Society was formally awarded to Prof. G. J. Allman, F.R.S., for distinguished researches in zoology, and, in consequence of his inability to receive it in person, was delivered on his behalf to Sir Joseph D. Hooker, K.C.S.I., who made a suitable acknowledgment. The Treasurer then presented his annual statement of accounts. The Secretary reported the deaths, withdrawals, and elections during the past year. The report of the Librarian having been read, the President opened the chief business of the evening, when the Fellows present proceeded to ballot for the President, Officers, and Council for the ensuing year. Scrutineers having been appointed, and the votes counted, the result was declared to be as follows:—President, Dr. Albert Günther, F.R.S.; Treasurer, Mr. Frank Crisp; Secretaries, Mr. B. Daydon Jackson and Prof. G. B. Howes. The retiring President, Mr. C. B. Clarke, then delivered the annual presidential address, which on the motion of Mr. W. Carruthers, seconded by Mr. W. P. Hiern, it was resolved should be printed and circulated.

Mathematical Society, June 11.—Major MacMahon, R.A., F.R.S., President in the chair.—The Chairman announced that the Council had awarded the De Morgan Memorial Medal to Mr. S. Roberts, F.R.S. He also read an address which the Council had requested him to present to Lord Kelvin on the occasion of the jubilee celebration on the 16th instant. The address, which was illuminated, was placed for inspection on the table. The following communications were made:—Waves in canals, by H. M. Macdonald; on the *a*, *b*, *c* form of the binary quintic, by J. Hammond; construction for the four normals to a central conic drawn through a given point, by Prof. Mathews; on a two-fold generalisation of Stieltjes' theorem, by Dr. Taber; notes on magic squares, by Rev. A. H. Frost.

Entomological Society, June 3.—Dr. D. Sharp, F.R.S., Vice-President, in the chair.—Mr. Gervase F. Mathew exhibited the new species of Leucania, *L. flavicolor*, recently described by Mr. Barrett (*Ent. Monthly Mag.*, 2nd series, vol. vii. p. 99), and also the varieties of *L. pallens* noticed by Mr. Barrett in the same article (*l. c.*, p. 100). Mr. Tutt having carefully examined the specimens of *Leucania flavicolor*, said that he considered it

as highly probable that it was a remarkable form of *Leucania pallens*, but that more material was required before a final opinion could be formed. The remarkable transverse (elbowed) line of dots crossing the forewings was exactly parallel with that of *Leucania straminea* and *L. impura* ab. *punctalinea*, and for an aberration of this character to occur in *L. pallens* was as probable as in *L. impura*, the typical form of which is but sparingly dotted in the direction of the elbowed line. The hindwings showed almost identically the same characters in the dark shading, traces of dots in nervures, &c., as the red aberrations of *L. pallens* exhibited by Mr. Mathew. He considered that until the matter of its specific distinctness was finally settled, Mr. Barrett had erred on the right side in giving it a distinctive name, even if the name subsequently fell as an aberration of *L. pallens*.—Mr. Waterhouse exhibited several branches of oaks from the New Forest entirely denuded of foliage, and stated that throughout large tracts of the forest the oaks had been stripped of their leaves in the same fashion by Lepidopterous larvæ, especially *Cheimatobia brumata*, *Hybernia defoliaria*, and *Tortrix viridana*. Certain trees, however, though situated among the denuded trees, had quite escaped. Dr. Sharp suggested that they belonged to a different species; but Mr. Waterhouse said that he had carefully examined them, and that this was not the case. Mr. McLachlan said that the immunity of the trees referred to was probably due to irregularity in coming into leaf. —Mr. Tutt exhibited living pupæ of *Enodia hyperanthus* and *Epinephele ianira*, and pointed out how different the pupæ of these two species were in general appearance, structure, and cremastral attachment from each other. He pointed out that these two species had for a long time been erroneously placed in the same genus, but that, in all stages, they were widely separated, and that not only should they be placed in different genera, but that they appeared to belong to different tribes—*Enodia hyperanthus* being in the *Cœnonymphidi* and *Epinephele ianira* in the *Epinephelidi* (*vide Entom. Record*, vii. p. 301).—Mr. Blandford exhibited and described series of tropical American butterflies from the Godman-Salvin collection, arranged to show the existence and geographical distribution of homœochromatic groups.—Dr. Chapman communicated a paper on the phylogeny and evolution of the Lepidoptera from a pupal and oval standpoint.

Geological Society, June 10.—Dr. Henry Hicks, F.R.S., President, in the chair.—On foliated granites and the relations to the crystalline schists in Eastern Sutherland, by J. Horne and E. Greenly. The crystalline schists of Eastern Sutherland are traversed by great numbers of granitic intrusions, chiefly in the form of lenticular sills. These generally lie parallel to the foliation-planes of the schists, but transgressive junctions are also frequent. Thin seams of granite also occur in such abundance as to constitute with the schists a banded gneissic series; but these seams can often be seen to transgress the schistose folia, and even often to proceed from large masses of granite. The granites contain numerous inclusions of the schists which they traverse, such inclusions retaining, usually, the dip and strike of the surrounding rocks. There are no chilled edges; and, moreover, the component crystals of schist and granite mutually interlock along the line of junction. The authors gave an account of the foliation of the granite. In some rare cases a foliation parallel to that of the schists traverses granite-veins. It is generally, however, parallel at once to the sides of the sill and to the foliation of the schists; and many of the structures are the remains of biotite folia belonging to schists whose quartzo-felspathic elements have been incorporated with those of the granite. But many sills or veins, traversing the schists at various angles, are foliated parallel to the line of junction, and so discordantly to the structures in the schists; and foliated granites may even be observed to cut each other's foliation. These can hardly be anything but original igneous structures; but, if coexistent with the last-named, would be indistinguishable from it. The country-rocks are various types of biotite-schist or gneiss, with quartz-schists at Kildonan, and a scapolite-limestone at Armadale. They are almost all holocrystalline, but it is certain that sedimentary rocks enter into the complex. The whole series is powerfully folded. The granites increase in size and numbers north-westward from Kildonan; the intimate intrusive relations above described becoming more highly developed in the same direction. The schists, at the same time, become more and more highly crystalline, sillimanite also appearing in them. About Kinbrace they are coarse sillimanite-biotite-gneisses, with large striated felspars. Igneous contact was not held to be the sole origin of metamorphism, though the cause which brought about the introduction of the granites had evidently also produced these high types of crystallisation. The evidence of powerful movement which the schists everywhere present suggested that such movement was the initial cause of the whole series of phenomena. Movement recurred throughout, though all cataclastic structures (if such existed) had been wholly effaced by crystallisation; introduction of granite being the final stage in the production of the complex, and a high temperature (as shown by the absence of chilled edges) being maintained to the very end. With regard to the granites, the authors found it difficult to believe that they are wholly foreign matter, but remark that it is necessary to observe the utmost caution with reference to it.—The geology of the eastern corner of Anglesey, by E. Greenly.—Seismic phenomena in the British Empire, by M. F. de Montessus de Ballore, Captain of Fortress Artillery at Belle-Ile-en-Mer. The author gave a brief outline of a plan that he has elaborated for studying seismology. He has separated his work into four parts: (1) The formation of an earthquake catalogue. (2) Refutation of the empirical laws previously ennuciated. (3) Description of the globe from a seismological point of view. (4) Investigation of the characters which differentiate stable from unstable regions. He gave a method by which the relative *seismicity* (or instability as regards earthquakes) of regions may be obtained and registered, and indicated some of the results which he had derived from his study, including the intimate relationship between instability and surface-relief, and the independence of seismic and volcanic phenomena. The main part of the paper was a section of the third division of the author's work, and dealt in detail with the earthquakes of the British Empire. In this part of the paper, the recorded earthquakes of the British Isles, India, Australia and New Zealand, British Africa, Canada, and various scattered possessions were described.

EDINBURGH.

Royal Society, June 15.—Prof. Geikie in the chair.—Mr. A. T. Masterman read a note on the structure of *Actinotrocha* considered in relation to the chordate affinities of *Phoronis*. In this paper, the author demonstrated the presence of a paired notochord in *Actinotrocha* which atrophies before the adult stage is reached, probably at the metamorphosis. He also showed the presence of five body-cavities in the larval stage. For these and other reasons he claimed for *Phoronis* a place among the Chordata, and proposed to place it in a separate division of this group—the Diplochordata. The relationship of *Phoronis* to *Balanoglossus* may be compared to that of the *Tunicata* to *Amphioxus*.—Prof. Tait read a paper on Clerk-Maxwell's law of distribution of velocities in a group of equal colliding spheres. He adverted to the extraordinary denunciation by M. Bertrand of Clerk-Maxwell's proof of the fundamental law of the kinetic theory of gases. He showed that Maxwell's proof involved none of the absurdities alleged by M. Bertrand, and that the gist of the matter was this:—There is a *unique* solution of the problem: Maxwell's is *a* solution, because it is not interfered with by collisions; therefore it is *the* solution.—Prof. Chrystal gave a summary of a paper on the p discriminant of a differential equation of the first order, in which he applied Newton's method of approximation (first employed in the theory of differential equations by Briot and Bouquet) to prove some leading theorems regarding the p discriminant locus, most of which had previously been established by Darboux by other methods. He showed that the p discriminant locus (A), $\phi(x, y, p) = 0$, $\phi_p(x, y, p) = 0$ is, in general, a cusp-locus for the family of integral curves. He also established that the locus, $\phi(x, y, p) = 0$, $\phi_x(x, y, p) + p\phi_y(x, y, p) = 0$, is in general an inflexion-locus (B), and that $\phi(x, y, p) = 0$, $p\phi_x(x, y, p) - \phi_y(x, y, p) = 0$ is a locus of inflexions on the orthogonal trajectories of the integral family (C). Any point of intersection of A and B, is, in general, a point at which two integral curves touch each other, and also touch A. The necessary and, in general, sufficient condition for an envelope singular solution is that A and B have a branch in common. The necessary and, in general, sufficient condition that two integral curves touch, and do not touch A, is that A, B, C have a point in common. The necessary and, in general, sufficient condition for a tac-locus is that A, B, C have a branch in common; the characteristic of this branch appears as a squared factor in the p discriminant. Prof. Chrystal then proceeded to refute a proposition of Cayley's, "that a differential equation of the first

order, which has no singular solution, cannot have an algebraic integral." He showed that Cayley's proof that every algebraic family has a proper envelope, on which this conclusion regarding differential equations depends, fails to take account of the fact that the residual points of intersection, $m + n$ in number, may be concentrated in isolated points, usually tac-points; and produced examples of cubic and quartic families which, in point of fact, have no proper envelope.—Prof. Ewart gave a summary of a paper by Mr. Frank J. Cole, on the cranial nerves of *Chimæra monstrosa*, with a discussion of the lateral line system, and of the comparative anatomy of the chorda tympani nerve.

PARIS.

Academy of Sciences, June 15.—M. A. Cornu in the chair.—Formula for the mean local pressures in a fluid moving irregularly or in vortices, by M. J. Boussinesq.—On the variations observed in the composition of apatites, by M. Adolphe Carnot. In Canadian apatites some of the calcium fluoride would appear to be replaced by calcium carbonate without change of crystalline form. In some apatites from the Tyrol, which presented the crystalline properties of normal apatite, the amount of calcium fluoride is reduced to about one-tenth of that usually present.—On the presence of *Campodea staphylinus* (Westwood) and *Sabacon paradoxus* in the cave of Dargilan (Lozère), by M. Lannelongue.—Remarks on the preceding communication, by M. E. Blanchard.—On the value as food of bread from different specimens of screened flour, by M. A. Girard. From a comparative study of the amounts of phosphorus in various samples of bread, the conclusion is drawn hat there is no real justification for the use of brown bread in preference to white, when the digestive organs are in a healthy state.—Observations and remarks on the bactericidal power of blood serum, and on the bactericidal substance contained in it, by M. S. Arloing. The experimental results obtained do not appear to sustain the idea of a specific substance in the serum of bactericidal properties. It was found that solutions of many salts could replace the solution of common salt as a diluent of the serum without appreciably affecting its action upon bacteria.—Measurement of the work expended in driving a bicycle, by M. Bouny. The work done was measured by a pedal of special construction containing two dynamometers, arranged so as to register the force exerted in two directions at right angles to each other, and also so as to take into account the effect produced by the deviations of the pedal from the horizontal plane. The work done by the pressure on the pedal is given as a function of the speed. To double the velocity (17 to 33 kilometres per hour) more than trebled the work required to be done.—Remarks on the preceding communication, by M. Marey.—On apsidal surfaces, by M. A. Mannheim.—On the theorem stated by M. P. H. Schoute in the *Comptes rendus* of May 18, by M. D. J. Korteweg. A simplification of one part of the demonstration of this theorem.—On the note of M. P. H. Schoute, entitled "The area of parabolas of higher order," by M. G. Mannoury.—On the method of least squares, by M. Jules Andrade.—On multiple resonance of electric oscillations, by M. Nils Strindberg An experimental study of the theory of MM. Poincaré and V. Bjerknes on the phenomena of multiple resonance, discovered by MM. Sarasin and De la Rive. By the use of a new form of electro-dynamometer based upon the Joule effect, it has been found possible to determine completely the form of the curves of interference. Qualitatively, the results obtained verify the above theory.—Non-isotropic magnetisation of crystallised magnetite, by M. Pierre Weiss. From the fact that magnetite crystallises in the cubic system, complete symmetry of magnetic properties in all directions might be expected. The experiments detailed, however, show that this is not the case.—On the surfusion of water, by M. J. Passy. It is possible to produce a precipitate in surfused solutions without causing crystallisation to begin.—On the diurnal variation in rain, by M. A. Angot. In summer the maximum amount of rain at Paris falls between 3 p.m. and 6 p.m. In winter the maximum, which is not so well marked, appears to be between 6 a.m. and 9 a.m. In March, April, October, and November there is no appreciable daily variation.—Dissociation spectra of fused salts. Alkali metals: sodium, potassium, lithium, by M. A. de Gramont.—On the reproduction of colours in chromotypography, and on a simple system of colour notation, by M. Steinheil.—On a reaction of cuprous compounds serving as a characteristic test for nitrites, by M. Paul Sabatier. A solution containing a nitrite, treated with concentrated sulphuric acid and a little cuprous oxide, gives a characteristic violet colouration.—On the zirconotungstic compounds, by M. L. A. Hallopeau.—Synthesis of natural methylheptenone, by MM. Ph. Barbier and L. Bouveault.—Contribution to the study of the anterior region of the digestive apparatus of the higher Stenoglossia, by M. A. Amaudrut.—Artificial reproduction of a chlorocarbonate of sodium and magnesium, and a double carbonate of the same bases. Artificial reproduction of darapskite and hydrargylite, by M. A. de Schulten.—On the rare minerals of the glacier of Meije, by M. A. Lacroix. The minerals include anatase, brookite and turnerite.—Chalk containing hippurites of the eastern province, by M. H. Douville.—On the presence of a genus allied to *Caprina* in the limestone at Chateauneuf-du-Rhône (Drôme), by M. V. Paquier.—On the relations between thermal sensibility and temperature, by M. C. Henry.—Action of the porcelain filter upon snake venom; separation of the toxic substances and vaccinal substances, by M. C. Phisalix.—On some derivatives of diphenylethylene diamine, by M. C. Gassmann.—Studies on peridinitronaphthalene, by the same.—On a method of observing sun-spots, by M. Bougon.

BOOKS AND SERIALS RECEIVED.

BOOKS.—Report of the Sixth International Geographical Congress held in London, 1895 (Murray).—Statistical Atlas of India, 2nd edition (Stanford).—Rivers and Canals: L. F. Vernon-Harcourt, 2 Vols., 2nd edition (Clarendon Press).—Domestic Science Readers: V. T. Murché, Book 3 (Macmillan).—The Story of Electricity: J. Munro (Newnes).—Hegel's Philosophy of Right: translated by Dr. S. W. Dyde (Bell).—Das Süsswasser-plankton: Dr. C. Apstein (Kiel, Lipsius).—Voxometric Revelation: J. Abner for A. A. North (Authors' and Printers' Joint Interest Publishing Company).—Text-Book of Zoology: Dr. J. E. Boas, translated by J. W. Kirkaldy and E. C. Pollard (Low).

SERIALS.—Economic Journal, June (Macmillan).—Royal Natural History, Part 32 (Warne).—Madras Government Museum, Bulletin No. 4 (Madras).—Journal of the Institution of Electrical Engineers, June (Spon).—Lloyd's Natural History. British Birds. Part 2 (Lloyd).—Himmel und Erde, June (Berlin).

CONTENTS.

THURSDAY, JULY 2, 1896.

THE CELL-THEORY.

Leçons sur la Cellule Morphologie et Réproduction faites au Collège de France pendant le semestre d'hiver 1893–94. Par Félix Henneguy. Pp. xix + 541. 362 figures. (Paris: Georges Carré, 1896.)

THE cell occupies, and has for half a century occupied, so important a position in biological science, that the literature dealing with it and the number of general works called up by this literature has become enormous, and is daily increasing. Nor is this a matter to be wondered at, for the subject is one of supreme importance to the biologist, and contains within its border the very innermost mysteries of life. But in saying this, we do not wish to be understood as giving our adhesion to this or to that modern school of thought with regard to the importance of the cell in organisms. It is sufficient for us to note the fact that, great as has been the influence of the conception of cell on biological investigations in the last fifty years, the chief merit of the founders of the cell-theory lay less in giving us that conception than in fixing attention upon the matter of which the organism is composed. To the cell-theory we owe our conception of the organism as a body composed of protoplasm—the real living matter, and of formed material—the non-living or semi-living framework. The former is the true seat of life, and the latter is produced as a result of its vital activity. This conception has been an analytical tool of the most powerful kind, and has assisted very considerably in the task of unravelling the complexity of structure and function of the parts of organisms. The cell-theory first fixed our attention upon protoplasm, and upon that most important part of protoplasm the nucleus; and it is to the study of protoplasm and of the nucleus, of their structure, relations, and activities, that the great advances in modern biology are due. This, we repeat, was the great work of the founders of the cell-theory. But they did more than this: they first showed us that the living substance is often arranged in and works through small structural units called cells; and they first gave us the idea that the organism is composed of independent or semi-independent individuals associated together in a colony for the common good. It is this idea, this hypothetical explanation of cellular structure, which constitutes the cell-theory; and it must be clearly borne in mind that the promulgation of this hypothesis was the least important part of the work of the founders of that theory. At the same time it is an undeniable fact that this hypothesis was held, and indeed is held largely at the present day; and that it has had a most important influence upon biological research. Of its value we express no opinion, but we should be wanting in our duty if we did not point out that of late years a slowly increasing number of biologists have cast doubts upon its validity and utility as an explanation of cellular structure, and are content to hold for the present that cellular structure has not received any adequate explanation, or, to use the somewhat vague words of Sachs, is a phenomenon of secondary significance, and merely one of the numerous expressions of the formative forces which reside in all matter, and in the highest degree in organic substance.

It is obvious that a work dealing with the cell in this wide sense, viz. as an equivalent for protoplasm and nucleus, must have a very large scope indeed; for if complete, it would include the whole of vegetable and animal histology and physiology. Owing to human limitations, it is in these days impossible for a single author to take this wide outlook, and we find in works dealing with the cell restrictions of various kinds. As a general rule, an author will limit himself to animal or to vegetable protoplasm, and a full consideration of the formed material is nearly always excluded. The part of the subject to which special attention is devoted—at any rate in recent works—is the structure of protoplasm, and of the nucleus and the behaviour of the nucleus in division and in conjugation. M. Henneguy is not content with any restriction of this kind, and though modestly disclaiming all idea of giving a complete account of the subject, and of having written a treatise on Cytology, he has in our opinion produced a more complete work on protoplasm and the nucleus than any of his predecessors. The work represents a course of thirty-one lectures given at the College de France in the winter of 1893–4, and is an admirable account of the state of our knowledge to that date. The author deals both with animal and vegetable protoplasm, with its chemical and physical constitution, with its structure, with the nucleus, the change which it undergoes and its relation to the cytoplasm, and with its division and its conjugation. An account of the nutrition of the cell, of the products of cellular activity, and of its functional differentiation, occupies a prominent place in the work. Finally he has a chapter on the relation of cells to each other, and another on the most important hypotheses on the constitution of protoplasm, and he begins the work by an excellent account of the growth of knowledge on the subject.

The work is of course a didactic one, and in no sense is to be regarded as an original contribution to knowledge. The author's object is to give an account of the facts which have been definitely established, relegating to the second place controversial or doubtful matters.

And in this he does well, for, as he points out, the tendency at the present day among a certain class of small workers to premature publication and to hasty generalisation, leads to most disastrous results in the accumulation of third-rate literature. A single fact, which often turns out to be no fact at all, is hidden in pages of raw and worthless speculation. "Another cause assists in accentuating this pernicious tendency. In certain schools far too much emphasis is laid upon new and still controverted observations, and classical works confirmed by numerous and reiterated observations are too often neglected, and future observers thus deprived of a sure and solid basis." He devotes a special section to the consideration of the effects of the different kinds of reagents used by histologists in altering the structure of protoplasm, and he calls the attention of his readers to the importance of the study of living protoplasm, and of checking all their results by it. This is a most important point, too often lost sight of in the rush and petty

ambition of modern laboratories, and one which cannot be too strongly impressed on young workers.

The author's treatment of that most important subject of protoplasmic fusion is not entirely satisfactory. He distinguishes two kinds: (1) fusion in which several cells unite to form a multinucleated mass, as in the *Mycetozoa* and some *Rhizopoda*; (2) conjugation, in which two or more cells fuse to form one cell; the distinction being that while in the latter case the process is accompanied by nuclear fusion, in the former it is not. In the first place it must be noted that conjugation does not always result in the formation of one cell from two, *e.g.* many ciliate infusoria; and in the second, that it is by no means certain that nuclear fusion does not occur between the nuclei of the multinucleated masses resulting from fusion. Moreover the author falls into the common error, found even in some of the best text-books, of calling conjugation a mode of reproduction. On p. 416 he says, "J'arrive maintenant à une mode spécial de reproduction, cellulaire que nous connaissons déjà, à celui que nous avons désigné sous le nom de *conjugaison* et que nous avons distingué de la *fusion*." It is perhaps hardly necessary to point out that by reproduction the number of individuals of a species is increased, while by conjugation it is generally diminished. It is true that conjugation results in the formation of a new individuality, but not in the increase in the number of individuals.

It is hardly going too far to say that conjugation is the opposite of reproduction. It is curious that this mistake should so often be made, and it is most important to call attention to it; for the confusion between the two processes, which has no doubt resulted from their accidental association in sexual reproduction, has considerably interfered with the proper appreciation of that most mysterious and important of vital processes—fusion of nuclei and protoplasm.

With regard to technical terms, we may be allowed to call attention to our author's use of the word *Cytodieresis*. He proposes this word for the process of cellular division, which is accompanied by those characteristic transformations of the nucleus which are ordinarily termed karyokinetic, reserving the word *division* for those cases in which the nucleus divides directly. We do not inquire whether such a word is required, but we desire to point out that on the very next page (296), our author uses the word Cytodieresis as the equivalent of *Caryodieresis* (indirect nuclear division). He says: "*Division indirecte* (of the nucleus) = *karyokinesis* (Schleicher) = *cytodieresis* (Henneguy) = *mitosis* (Flemming)." The looseness of thought implied by this confusion in the use of his own word is unsatisfactory, and would by some biologists be pointed to as an example of the result of too strongly holding to a theory which does not conform with all the facts.

In criticising Weismann's suggestion that the Protozoa are immortal, he says that "a Protozoon which divides dies in the sense which we attach to the death of the higher animals, *i.e.* that its individuality disappears." Though we are quite willing to admit that Weismann's statement was more of the nature of a gallery phrase designed to catch the ear of the readers of the modern magazine article, than a serious contribution to science, and that it conveyed no new idea or suggestion, we cannot follow M. Henneguy in his criticism quoted above. For do not the higher animals also undergo numerous successive divisions in the production of their reproductive cells, which differ in no essential particular from the successive binary fissions which a Paramœcium passes through in its life-history. The only difference which can be pointed to is one merely of degree; for there is no more an absolute similarity between the two products of fission in an infusorian than there is between the products of the fission (ovum or spermatozoon and parent) which is continually taking place in the higher animals. You might just as reasonably assert that a hen dies whenever it lays an egg, as make the statement that a Paramœcium dies at each process of fission. With the words death and individual a philosopher can do much; but it behoves practical men to keep a sharp look-out on the use made of those convenient terms.

The book is well printed and illustrated; and though it is not a complete and carefully elaborated treatise on protoplasm, as the author himself is the first to admit, yet it constitutes a valuable addition to the biologist's library, and cannot fail to be of great use to the teacher as well as to the student.

A ROMANTIC NATURALIST.

From North Pole to Equator, Studies of Wild Life and Scenes in many Lands. By the Naturalist-Traveller, Alfred Edmund Brehm. Translated from the German by Margaret R. Thomson. Edited by J. Arthur Thomson, M.A., F.R.S.E. (London: Blackie and Son, Ltd., 1896.)

"BETWEEN North Pole and Equator" might have been a less attractive, but would have been a more accurate title for this book, for Siberia and northern Norway are not as far north as the Pole, nor are Nubia and the Blue Nile as far south as the Equator. Between these limits, however, the late Dr. A. E. Brehm made extensive journeys, visiting most of the principal types of country that may be found therein, and studying the characteristic faunas with the enthusiasm of a born naturalist. His great "Thierleben" is a rich repository of information on the habits of animals, the various groups of which are taken in zoological order. The present book appears to be intended as a supplement to this; for it is geographical in arrangement, and consists of a series of graphic sketches of wild life in many lands.

The work opens with a brief homage to the author by his son, and then an admirable introductory essay by the editor upon the work of naturalist-travellers in general, and of A. E. Brehm in particular. Mr. Thomson gives a list of works by English naturalist-travellers, in which we notice Fred Burnaby's "Ride to Khiva," although such books as Lamont's "With the Sea Horses," Butler's "Great Lone Land," and Whymper's "Travels among the Andes of the Equator," are not mentioned.

Mr. Thomson classifies naturalist-travellers into five groups—the Romantic (including Sir John de Maundeville and other mediæval story-tellers); the Encyclopædists of the sixteenth and seventeenth centuries; the General Naturalists, ranging from Ray to Humboldt; the Specialist Type—the naturalists of the naval expeditions

of the present century; and the Biological Type, such as Darwin, Wallace, and Bates. Mr. Thomson includes Brehm in the last group; but if we accept his definition of the Romantic Type (p. xvi.), Brehm has certain claims to be placed among these. "In days when the critical spirit was young," Mr. Thomson tells us, and "verification hardly possible; there could not but be a strong temptation to tell extraordinary 'traveller's tales.' And they did. Nor need we scoff at them loudly, for the type dies hard; every year such tales are told." We have only to turn to p. 38 to see a proof of this. There we learn that in the fiords of northern Norway "the fish swim so thickly that the boat has literally to force a way among them, . . . that an oar placed upright among the densely-packed crowd of swimmers remains for a few moments in its position before falling to one side." Or on p. 83, where we are told that in the tundra "every grass-stalk, every moss-blade, every twig, every branch, every little leaf sends forth hundreds and thousands of them [mosquitoes] all day long." After this we are prepared to learn that the mosquitoes "form swarms which look like thick black smoke; they surround, as with a fog, every creature which ventures into their domains: they fill the air in such numbers that one hardly dares to breathe; they baffle every attempt to drive them off; they transform the strongest man into an irresolute weakling, his anger into fear, his curses into groans." These are samples of the author's style, and of the precision of his descriptions. His book is written in superlatives, which appear to be laboured, and is full of humour, which is generally unintentional. But in spite of the author's command of impressive language, he is very modest; the heat of Africa, he tells us, is "indescribable," and then does his best in a page full of sentences, such as the following. "The torments are inconceivable." "Nor can any one who has not groaned through these nights, when one tosses on the couch, prevented by the sultriness from resting or sleeping, adequately sympathise with the torments to which men and animals are subjected at this season." "Men and beasts seem to wither as the grass and leaves withered." "In vain does manly courage endeavour to bear up under the burden of these days; the most resolute will give way to sighs and moans. Every piece of work fatigues, even the lightest covering is too heavy, every movement is an effort, every wound becomes a virulent sore." After this we are not surprised to find an account of a tropical thunderstorm and its effects, written in language that reads like an American journalist's report of the Johannesburg dynamite explosion; and that, in escaping the steppe fires, "antelopes, zebras and ostriches speed across the plain more quickly than the wind"; or that a view of the baobab is described as "a sight which stamps itself ineffaceably on the memory," and that nothing in the African forest can compare with it "in charm and impressiveness," as when it flowers "this incomparable giant is transformed, as if by magic, into an enormous rose-bush of indescribable beauty, the sight of which stirs the heart of even the most matter of fact of men with admiration." This appears in a chapter on the "Primæval Forests of Central Africa," though as a matter of fact the author never seems to have entered any of the real African forests; in these, indeed, the baobab is not found, it being characteristic of the steppes and scrub-covered plains. In respect to the doleb palm, we are told on the same page that "its trunk is a pillar which no artist could have surpassed; its crown a capital worthy of such a pillar." After such a compliment, this palm cannot complain at the description of the shape of its stem being exactly contrary to the facts, it thickening at half its height from the ground instead of thinning. According to the author's account, although he tells us that Northern Africa "is desert, must be desert, and will be desert for ever," it appears to be a remarkably well-peopled desert. He says that one of the most indispensable articles in an African traveller's outfit is a pair of long-legged tongs, with which to seize the vermin that swarm into camp at night, drawn by the fire. "Attracted by the light, noxious creatures come running and creeping, first one and then another, but soon in tens and in hundreds. First appear gigantic spiders, which, with their eight legs spread out, cover a surface as large as an outstretched hand. After the spiders, or sometimes along with them, the scorpions come hurrying. Both spiders and scorpions rush with sinister rapidity to the fire, clambering over carpet and coverlet, among the dishes of our simple supper, retreating when the radiating heat becomes too strong for them, turning back again under its mesmeric influence—in truth a fearsome invasion.' After these "hellish brood" come the vipers, "unmistakably on the spot," in "terrifying numbers," which "drive one almost to despair." We fear that any one who imagines that he has only to light a fire on an African steppe to be able to fill his cases with all sorts of interesting animals, which rush to him, like rats to Bishop Hatto, would find zoological collecting less exciting and profitable than he would have expected from Brehm's description.

We have given many extracts from this work, as the best method of illustrating its nature. The book is well printed and illustrated, and the translation is very readable. Only we do not see that there is very much in it worth reading. Every page is distorted by such ludicrous exaggeration, that the descriptions run dangerously near to bathos and caricature.

OUR BOOK SHELF.

The Spas and Mineral Waters of Europe, with Notes on Balneo-Therapeutic Management in Various Diseases and Morbid Conditions. By Hermann Weber, M.D., F.R.C.P., and F. Parkes Weber, M.D., M.R.C.P. 8vo, pp. 380. (London: Smith, Elder, and Co., 1896.)

This book contains in a brief space a large amount of most useful information in regard to the spas and mineral waters of Europe. It gives the position of the various spas, their climate, baths, and mode of access, with a list of doctors and general indications of the class of cases which are benefited by the waters. Besides an enumeration of the various spas, there is a second section dealing with diseases, and mentioning the spas most likely to be useful in each. In addition to this, a full bibliography is given.

The value of the book consists, not merely in its convenient arrangement, and in the information it gives, but in the fact that most of this information is the outcome of personal knowledge on the part of the authors This gives it a precision and value which is not always

to be found in works on this subject, because the time and expense involved in visiting personally all the spas of Europe is very great, and few physicians are able to accomplish such a feat.

Domestic Science Readers. By Vincent T. Murché. Book iii. Pp. 176. (London: Macmillan and Co., 1896.)

IN the subject of domestic economy, for Standard III., the Education Department require knowledge of the chief materials used in clothing and washing, *e.g.* silk, linen, wool, cotton, fur, leather, and washing materials. This book supplies that knowledge in a form attractive to juvenile minds. The children who read the book will acquire useful information in an easy manner.

The Story of Electricity. By John Munro. Pp. 194. (London: George Newnes, Ltd., 1896.)

A SIMPLE and accurate story, containing brief but clear descriptions of the principles and applications of electrical science. The book will educate the public in the knowledge of the great achievements of electricity, and will create an interest in scientific things.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Zoological Publications.

WHEN the rules for zoological nomenclature are next under discussion, it might be advisable to include a clause relative to the discretion of editors in dealing with authors' contributions to scientific journals.

My paper (*Journal* of the Linnean Society, xxv. p. 325), before publication, was entitled "The Egg-case of Port Jackson Sharks," and it was presumed that the Port Jackson sharks, popularly so known, would be thereby understood.

As the length of time occupied by postal transit to and from London might unnecessarily delay publication, I did not ask for a proof. On receiving my copy of the *Journal*, I found that the title was altered to "On the Egg-cases of some Port Jackson Sharks;" thus the purport of the title was destroyed. Perhaps this is a small matter. One affecting me more nearly is the substitution of the name "*Cestracion*" for *Heterodontus*, which I used.

Heterodontus may be right or it may be wrong; but, as author of the paper, having adopted that name, I submit that it should have been retained. At the same time, there could be small objection to an editorial foot-note. EDGAR R. WAITE.

Australian Museum, Sydney, April 28.

THE appellation "Port Jackson Shark" is customarily applied to *Cestracion Philippi*. Macleay, as is well known, doubted the justice of including in this species the Japanese *Heterodontus zebra* (Gray); and as Mr. Waite, admitting the independence of the latter species, extends the vernacular name to *C. galeatus*, the alteration in the title of his paper is regretable, though not serious. It was made without my sanction, and I am sorry to say that it escaped my notice in the performance of my editorial duties. Had I detected it, I should not have allowed it to pass.

Concerning the substitution of *Cestracion* for *Heterodontus*, I would point out that although the latter name has priority by a year, no recent writers but Maclay and Macleay, so far as I am aware, have allowed it to stand; and that even were this not so, *Heterodontus* (1816) on the strict rules of priority in nomenclature is preoccupied by *Heterodon*, applied by Latreille to a snake in 1800.

When Mr. Waite's paper came before the Council of this Society, the matter was carefully considered, and, in accordance with instructions, I wrote him to the above effect, pointing out that I should substitute *Cestracion* for *Heterodontus* unless I heard from him to the contrary during the passage of his paper through the press. My letter was written early in July 1895, and the paper was published last February, ample time being thus allowed its author in which to reply. To this day no reply has been received. G. B. HOWES.

Linnean Society, London, June 19.

The Salaries of Science Demonstrators.

WILL you allow me to protest in your columns against what is nothing less than a public scandal, namely the advertisement by a University College, in your last issue, for a Demonstrator of Chemistry at a salary of £70 per annum?

A science demonstrator at a University College is, or should be, in some sense "a scholar and a gentleman"; and how, I ask, is a man of that type to support a decent existence on such a salary? The effect of this policy of accepting the lowest tender will be either to close such posts to those not possessed of private means—a result utterly at variance with the spirit of the time, and destructive of true efficiency—or to fill them with men of an inferior class, which would be no less harmful to the quality of our scientific education. Have we not a right to expect a more enlightened policy from the governing bodies of our University Colleges? Surely they must see that the haggling of the market does not afford the best means of fixing a teacher's reward. Even the general public cannot but recognise it to be in its own interest, that those who are chosen to educate its sons should be men of as deep knowledge and as wide culture as possible. And what width of culture and depth of knowledge can be attained on £70 a year, with the day fully occupied in the routine work of teaching, the general public itself can judge. Demonstrators of chemistry have, too, I think, peculiar cause for complaint; as a rule their duties are heavier than those of other science demonstrators, whilst their salary is the same.

In these days, even the miner has his minimum wage: cannot one be fixed for science demonstrators? It should not be less than £150, I think; certainly anything under £100 is scandalous, even in the present state of public opinion.

CHARLES FREDERIC BAKER.

Halley's Chart of Magnetic Declinations.

WITHIN the last few days I have come into possession of another early map showing Halley's lines. The date of this map is 1725, and it was published by John Senex, F.R.S. It is entitled "A Map of the World, corrected from the Observations communicated to the Royal Societys of London and Paris." The map consists of the two hemispheres, each of which is 21 inches in diameter. Around the margin in small print is Sir Isaac Newton's "Theory of the Tides," and "An attempt to Assigne the Physical Cause of the Trade Winds and Monsoons, by Dr. Ed. Halley." The map is particularly interesting, as it was evidently intended to give a full account of the winds, the directions of which in the trade winds and monsoons are indicated by arrows. Another interesting note in the margin is "Of the quantity of Vapour exhaled from the Sea, of its Circulation, and of the Cause of Springs," "Extracted from a Discourse published in the Philosoph Transact., No. 189, 192. Writ by Dr. Ed. Halley." What makes the map so interesting is the notes printed upon it referring to the magnetic declinations. The lines of magnetic variation for every 5° east and west of the line of no variation, are given in the Atlantic and Indian Oceans, but not in the Pacific.

The line of no variation is described as "The line of no variation in the year 1700." The following note is printed upon the Atlantic Ocean between the Azores and Cape Verd Isles. "These curve lines w^ch^ express y^e^ variation of y^e^ magnetical needle ware observed by D^r^ Edmond Halley for y^e^ year 1700, but it must be noted that there is a perpetual tho' slow change in the variation almost everywhere (viz.) about C. Bona Esperanza y^e^ W. variation increases about a Deg. in 9 years, in our Channel a Deg. in 7 years, on y^e^ Guinea Coast a Degree in 11 or 12 years, on y^e^ American side y^e^ W. variation alters but little: and y^e^ East variation on y^e^ S. America decreases y^e^ more Southerly y^e^ faster; y^e^ L. of no variation moving

gradually towards it." In the South of the Pacific Ocean called the Great South Sea or Mar del Zur is the following note. "The Line of no Variation y^t passes near y^e coast of China divides again y^e West from y^e East variations y^t in all probability is to be met with allmost all over this Immense Ocean; but have not attempted to describe the Curves therein wanting accounts and journals to ascertain the same." The line of no variation referred to in this note is marked on the map as passing to the west of Van Diemens Land—through New Holland and the East Indian Islands to China, and thence through China to the north of Pekin. In the Indian Ocean, just north of the Antarctic Circle, is the following note. "By the Variation of the Magnetical Needle or Mariners Compass is meant its deflection from the true Meridian, for it has been observed that there are but few places where its direction is true North but varies therefrom either to y^e Eastward or Westward in some places more in others less. Now this variation is of that great concernment in the Art of Navigation that the neglect thereof does little less than render useless one of the noblest Inventions Mankind ever yet attained to, for which reason we have here inserted them as they ware found by D^r Halley in y^e year 1700. The Curve Line passing over those places whose degrees of variation are superscribed."

The map is dedicated to the Right Honourable Richard Boyle, Earl of Burlington and Cork, &c., by John Senex, by whom it was drawn and engraved. It was "sold by J. Senex at the Globe against St. Dunstan's Church in Fleet Street, London, 1725."

THOS. WARD.

Northwich, June 13.

P.S.—I have just discovered the following note in the Indian Ocean to the South of Madagascar. "In this Indian or Eastern Ocean after you pass Madagascar y^e Westerly Variation was in y^e year 1700 on y^e decrease y^e faster y^e more Westerly and Southerly, and it was then in a manner at a stand when you came to the length of Java."

THE TOTAL ECLIPSE OF THE SUN.

THE following suggestions were compiled for a special purpose. As it is probable that many amateurs will take advantage of the coming occasion to observe the various phenomena, the suggestions are published here in the hope that they may prove useful to some who are witnessing a total eclipse for the first time.

J. NORMAN LOCKYER.

(1) *Time Observations.*

Observers who are supplied with a first-rate chronometer, of which the error and rate are known, may make valuable observations of the four contacts.

For the first contact a telescope is necessary to observe the first small encroachment of the moon on the sun's limb; of course, if a spectroscope is used to observe the gradual eclipse of the chromosphere indicated by the gradual shortening of one of the lines of hydrogen (C for choice), so much the better, but care must be taken by sweeping along the limb to secure that the chromosphere immediately above the first contact is under observation; here, of course, the line will be shortest.

The second contact will be heralded by the sweep of the moon's shadow through the air. Mr. Crommelin has calculated that in Norway this will move at the rate of two miles a second; the shadow on the land- or sea-scape will, of course, be best seen from the most elevated stations.

To observe the exact time of contact, a green shade should be used, as the disappearance of the white light of the photosphere and the appearance of the red light of the chromosphere will be emphasised. Prof. Harkness has also pointed out that the exact moment of second contact is also clearly indicated by the "seemingly miraculous appearance of the complete outline of the moon, round and black, reposing upon the wondrous radiance of the corona."

The approach of the third contact is indicated by the rapid brightening of the chromosphere at the point of the moon's limb where the sun is about to reappear. The green shade should again be used, and two or three seconds later a fine cusp of photosphere will make its appearance, announcing the termination of totality.

The green shade is here especially useful, as often the reappearance of the lower brighter chromospheric level has been mistaken for the reappearance of the sun itself.

For the fourth contact a telescope should be used if possible, otherwise a smoked glass.

It is desirable that, if possible, each party observing the contacts should consist of three persons; one to watch, without any interruption whatever, the face of the chronometer and to count the seconds immediately before each contact is expected, another to make the observation, and another to record the exact time, minute, second, and part of second at which the signal is given by the second observer.

(2) *Disc Observations.*

These observations are for noting the greatest extent of the corona, and can only be made by shore parties.

Calculate the altitude and azimuth of sun's centre, at place, at mid-eclipse. Make a disc of such a size that at a distance *from the eye* of 20, 30, or 40 feet, as may be decided on, it will cover the sun, and extend three minutes of arc beyond the limb all round.

Erect this on a vertical pole, so that from the chosen observing point it will eclipse the dark moon and the lower parts of the corona (3′ high) at mid-eclipse.

A hole should be cut in a piece of wood or cardboard, fixed at the proper height, to show the exact position of the eye. This should be free to move in altitude and azimuth to secure exact adjustment.

Test the accuracy of everything, if possible, the day before at the time the sun is nearest the mid-eclipse position.

Before totality one observer should make the adjustments before referred to, and should see that at ten seconds after the beginning of totality the lower part of the corona all round the dark moon is completely covered by the disc.

Another observer, whose eye has been lightly bandaged to make it as sensitive to faint light as possible, should then be placed at the eye-hole, and should look for the faintest extensions. He should dictate to an amanuensis the length of extensions in diameters of dark moon; and their bearing, the vertex representing magnetic north.

Immediately the totality is over, the actual observer should draw what he has seen on a card similar to that used by the sketchers of the corona (see later). This drawing should include everything seen, but the extensions should be noted with the greatest care.[1]

(3) *Eye Observations of the Corona.*

All can do serviceable work by sketching very carefully the corona during the time of totality. The observers should provide themselves with a card (or cards) one foot square, on which a circle two inches in diameter is drawn in ink, and darkened to represent the moon's disc. The diameter will serve as a scale, so that the distance the boundaries and rays of the corona extend from the dark moon may be carefully noted. Imagine both the dark moon and dark disc to represent a compass card, then the various details may be sketched at their appropriate bearings, the top of the card representing mag. N. (The points may be marked on the card in any detail that may be required, but eight should suffice.)

These observations should, if possible, be made by

[1] For phenomena thus observed in eclipse of 1878 see "Lockyer's Astronomy," p. 115.

observers in pairs, and they should not compare notes. If telescopes are used, two inches aperture and a power of twenty should be employed for choice.

Before Totality.

(I.) Note how long the corona is visible before totality, along the edge of the dark moon opposite the point at which the sun is about to disappear.

(II.) Sketch any rays visible before totality; give length, colour, and structure as well as position.

At Commencement of Totality.

(III.) Sketch general outline and rays (streamers) and rifts (dark intervals between bright rays.)

(IV.) Note if there be a blaze of light or glare where the sun has just disappeared, and whether the base of the corona is brightest near or away from prominences.

Middle of Totality.

(V.) Sketch general outline rays (streamers) and rifts; note colour and direction of greatest extension.

Near End of Totality.

(VI.) Sketch general outline, and any rays or streamers or rifts; note colours.

(VII.) Note if there be a blaze of light or glare where the sun is about to reappear.

After Totality.

(VIII.) Sketch any rays that may be visible; give length, colour, and structure, as well as position.

Questions to be answered in writing immediately Totality is over.

(*a*) Has there been any change in the appearance of the corona during the eclipse? If so, specify what change.

(*b*) Have especially the dark rays or rifts changed during the eclipse.

(*c*) Describe what has been unchanged throughout, and define its structure.

(*d*) State the colours you observed outside the red prominences.

(*e*) Were the colours anywhere arranged in layers round the sun?

(*f*) Were the colours anywhere arranged radially?

(*g*) State colours of rays, and of spaces between them.

(*h*) Did the dark rifts extend down to the moon, or did they stop short above the denser layers of the chromosphere?

(*i*) Were the rays brightest near, or far away from the moon?

(*k*) What was the comparative brightness of the rays, the bright ring near the sun, and the outer corona?

(4) *Colours of Land- and Sea-scape.*

Some time before totality there will be a notable change in the colours of sky, cloud, and land and water surfaces.

Each of these should be noted separately, and the gradual changes, both as totality is approached and after it is over, should be carefully recorded.

This apparent change of colour has its origin in the coloured chromosphere and prominences; those witnessing the eclipse are thus enveloped in coloured—generally red—light, which bathes the landscape. The sky, ordinarily blue, is seen through a red haze, and therefore puts on a purple tint.

That the sky appears more purple at some eclipses than at others, is owing to the fact that the quantity of red light is not always the same, but varies with the brightness and magnitude of the prominences visible at the time.

The following table will give an idea of the colours, both of the corona and landscape, which have been previously recorded.

Year	Inner corona	Outer corona	Rays	Landscape, &c.
1605	Reddish hue (Keple-)			
1715	Pale whiteness or rather pearl coloured (Halley)			
1733	Ruddy (Vatterini)	Greenish colour		
1766	Ruddy	Yellow and white		Livid yellow (Le Gentil).
1778	Reddish hue, pale yellow to white (Ulloa)			
1806			Bluish tint (de Witt)	
1842	Yellow			
1842	Peach colour (Airy)			Greenish olive (Pinaud) Greyish violet heavens at Lipesk.
1851	White first and then blue Dull rose colour Light violet			Land dusky yellow, water deep purple, clouds yellow, sky purple. — Dunkin.
				Sea and land dark green. Deep yellow colour beneath clouds in south. (Snow).
	Pure white Brightest (Carrington)	More feeble		Landscape dark olive tint (Hind).
	Silvery white (Swan)			Clouds deep purplish grey (Dawes)
	Light violet, nearly white (Silverstolpe) A cold unearthly light (Adams) Orange (Liveing)			A sickly neutral green coloured sea and tinged atmosphere.
1860	Yellow (Rümker)			
1869	Silvery grey (Farrell)		Fine violet mauve coloured white and yellowish white (Farrell)	
	Silvery white.	Greenish violet (Eastman)		
	Clear yellowish	Pinkish green (Myer)	Silvery	Bands of pink, purple, yellow, orange, fiery red, no green or blue except a blue tinge in purple, all divided by black stripes.

(5) *The Visibility of Stars during the Eclipse.*

The light radiated by the solar surroundings varies very much from eclipse to eclipse. Hence sometimes lamps are necessary for certain of the operations, while at others they are superfluous.

The number of stars visible, therefore, varies considerably. The sun this year at the time of the eclipse will be near the chief stars in the constellation Leo, which will be to the left of the sun.

Note, by means of a star map, what is the magnitude of the faintest stars visible, whether first, second, third, or fourth.

Suggestions for Timing the Progress of the Eclipse.

In Sicily, in 1870, the following method of recording the lapse of time during totality was introduced, and was found to prevent all excitement, and made the 80 seconds seem a long time.

Determine the number of seconds of totality at the station—say 100.

Then, at the moment of totality, let a person attached to each party of observers, carefully observing the face of a chronometer or watch, say, "You have now 100 seconds." After 5 seconds, "You have still 95

seconds." After another 5 seconds, "There are still 90 seconds remaining." And so on.

A clever man can do this in a very encouraging way. The time counter should take care not to distract himself by losing sight of the face of the watch or chronometer; and it is to be impressed upon him that much of the success of the observations will depend on his undivided attention, as his statement of time in the case of parties with large instruments, is an order to individual observers to do certain work. Hence there should be two time counters, who should change over at the middle of the eclipse, care being taken that the counting is not interrupted. *The times at which any of the phenomena occur must be noted by another observer.*

Caution with regard to the use of Telescopes.

Observers equipped with telescopes, whether they be small instruments or equatorially mounted, must be very careful about not observing the sun before or after totality without the aid of dark glasses. For small hand-telescopes a dark glass will be found sufficiently safe; but with instruments of greater power, the dark glass should be supplemented by a solar or diagonal eye-piece. If one half of the reflecting surface of the glass be silvered and the glass be made to slide, it may be used during totality. In any case, *do not forget, immediately before totality, to remove the dark glasses.*

THE KELVIN JUBILEE.

WE are glad to be able to supplement our report of the celebration of Lord Kelvin's jubilee with the address presented by M. Mascart on behalf of the Institute of France. By such cordial expressions as those in which the Institute addressed our distinguished countryman, men of science are made to feel that they belong to a universal brotherhood, all the members of which have but one aim—the accumulation of scientific knowledge. The following is the address:—

MILORD ET CHER CONFRÈRE,—L'Académie des Sciences de Paris, dans laquelle vous êtes aujourdhui le doyen des associés étrangers, a voulu se joindre aux savants de tous les pays du monde, à vos admirateurs, à vos amis, pour vous apporter des félicitations chaleureuses à l'occasion du cinquantenaire de votre arrivée comme professeur à l'Université de Glasgow que vous avez tant illustrée.

Il y a quelques mois, l'Institut de France célébrait le centième anniversaire de sa fondation, ou plutôt de la reconstitution des anciennes Académies sur des bases plus larges. Nous ne pouvons oublier l'élévation de langage avec laquelle le Président de la Société Royale de Londres vint alors traduire les sentiments de cordialité de cette grande et célèbre Institution.

Dans une autre réunion, où vous parliez en votre nom personnel, vous nous avez causé une profonde émotion en déclarant que vous aviez une dette de reconnaissance envers notre pays, que nos grand esprits tels que Fourier, Laplace et Sadi Carnot avaient été vos inspirateurs et que vous considériez la France comme l' "alma mater" de votre jeunesse scientifique.

Si la dette existe, vous l'avez payée avec usure. Dans la longue série de travaux et de découvertes qui jalonnent; votre admirable carrière, une des plus nobles que l'on puisse rêver, vous avez abordé toutes les questions des cette science a laquelle la littérature anglaise conserve le beau nom de "philosophie naturelle," soit pour contribuer aux progrès des conceptions théoriques, soit pour en déduire des applications utiles au développements de l'industrie et au bien de l'humanité.

Quoi que l'avenir réserve au génie inventif de l'esprit humain, votre nom restera comme ayant été le guide le plus sûr dans une époque féconde, et le véritable éducateur de la génération actuelle dans le domaine de l'électricité.

Je suis particulièrement heureux que l'Académie des Sciences m'ait confié le soin de vous remettre une médaille d'or à l'effigie d'Arago, médaille qu'elle réserve pour rendre hommage aux services exceptionnels rendus à la science et qui porte cette devise, "Laudes damus posteri gloriam."

Vos confrères de l'Institut de France espèrent que vous voudrez bien considérer ce souvenir comme un témoignage de haute estime et de leurs sentiments les plus affectueux.

It is due to the Council of the Royal College of Science to state that they were not less desirous than the rest of the scientific world of doing honour to Lord Kelvin. An address was prepared and signed by every member of the Council of the College, with the exception of one who was temporarily out of reach. This address was presented to Lord Kelvin at the same time as the addresses from other Colleges in London, but mention of it was inadvertently omitted from our report. A congratulatory address was also sent by the Institute of Chemistry.

THE BRITISH ASSOCIATION MEETING IN LIVERPOOL.—LOCAL ARRANGEMENTS.

THE preparations for the British Association Meeting in Liverpool next September are now going on rapidly. A large and influential Local Committee of about 500 of the leading citizens, under the chairmanship of the Lord Mayor (the Earl of Derby), was appointed a couple of years ago. The smaller Executive Committee has broken up into Sub-Committees dealing with the subjects of—(1) Finance, (2) Hospitality, (3) Buildings, (4) Excursions, (5) Publications, and (6) Evening Entertainments. Most of these Sub-Committees have been actively at work for the last few months, and a report embodying the results of their deliberations has just been submitted to a meeting of the large Committee held in the Town Hall. The following is an outline of the arrangements completed so far:—

The reception room and the general offices will be at St. George's Hall, in the centre of the town, a few yards from Lime Street Station, the London and North-Western Terminus. One of the Sections (Geography) will occupy the concert room of St. George's Hall, and three other Sections (Geology, Anthropology, and Mechanical Science) have been allotted rooms in the closely adjoining Public Museum and Walker Art Gallery. The Section of Economics will be located in the Town Hall, opening on to the Exchange flags, and in the centre of the business life of the city; while the five remaining Sections (Physics, Chemistry, Zoology, Physiology, and Botany) will be placed in the laboratories and lecture theatres of University College, about 1050 yards from the reception room. A main artery, and tramway route, leads from Lime Street to Ashton Street, from which the College opens, and arrangements will be made for a constant service of convenient omnibuses in addition to the tram-cars. Permission to use these various buildings has been obtained from the Lord Mayor and the Corporation, and the Council of University College; and the Philharmonic Hall, which holds about 3000, has been engaged for three evenings, on the occasions of the President's address and the two evening discourses. The lecture to the working classes will be given in the Picton Lecture Hall. The first conversazione will be given by the Lord Mayor (Lord Derby) in the Town Hall, and the second by the Local Committee in the range of Corporation buildings occupied by the Public

Museum and the Walker Art Gallery. The autumn exhibition will be open in September, and the Arts Committee propose to admit members of the British Association to the galleries during the week of the meeting on presentation of their tickets of membership.

A new museum, given to the zoological department of University College by the late Mr. George Holt, has been rapidly hurried on with the special view of use at this meeting, and will be available for the exhibition of specimens, models, &c., brought in illustration of papers read before the Sections, or for other objects of scientific interest sent on loan.

A number of the owners of works of manufacturing and engineering interest have offered to open their buildings for inspection during the week. Several gentlemen have intimated their intention of giving garden parties, and a number of excursions to places of interest in the neighbourhood of Liverpool have now been arranged, including the following: Half-day excursions on Saturday, September 19—(1) River excursion with the Mersey Dock Board; (2) Overhead Electric Railway; (3) Speke Hall, Hale Hall, &c.; (4) Thurstaston, Storeton Quarry (where the reptilian footprints are found), and the Leasowe Submarine Forest; (5) Bidston Observatory; (6) Chester and Hawarden; (7) Dredging excursion with the Lancashire Sea-Fisheries Steamer. Whole-day excursions on Thursday, September 24—(1) Chester and Eaton Hall; (2) Rivington Water Works, &c.; (3) Llandudno and Beaumaris by sea; (4) Manchester Ship Canal, &c.; (5) Prestatyn, Tremerchion Caves, and Corwen; (6) Northwich, Weaver Navigation, and Delamere Forest.

At the end of the meeting there will be longer excursions, extending over several days, to the Vyrnwy Water Works in Wales and to the English lakes; and a specially scientific excursion to the Isle of Man, for which a separate programme has been prepared, covering five days—Thursday to Monday inclusive.

The Earl of Derby has invited a party to Knowsley, the Duke of Westminster has also invited a party to Eaton Hall, and Mr. Gladstone will receive another party at Hawarden. In connection with the Isle of Man excursion, the Governor of the island (Lord Henniker) has invited the members to a reception at Government House, and will preside at a dinner to be given on the concluding evening.

The Publications Sub-Committee have drawn up a scientific handbook to Liverpool and the neighbourhood, containing articles on the history and antiquities, the geology, the entomology, the marine biology, the botany, the vertebrate fauna, the climate, the river and the tides, the docks and other engineering works, the trade and commerce, and the chemical industries. A complete guide to the various excursions is also in course of preparation.

The Hospitality Sub-Committee have invited as guests a large number of distinguished scientific men from the continent and America, and although many have not yet been able to give, at this early date, a decided answer, a considerable number have already definitely accepted. These include, amongst others, Prof. van Rijckevorsel (Rotterdam), M. J. Violle (Paris), Prof. V. Bjerknes (Stockholm), Prof. Lenard (Aachen), M. L. de la Rive (Geneva), Prof. Knorr (Jena), Dr. Credner (Leipzig), Prof. Renard (Gand), Prof. Mœbius (Berlin), Prof. Julin (Liège), Prof. Gilson (Louvain), Prof. Minot (Boston), Prof. Le Conte (Berkeley), Graf von Pfeil (Vienna), Prof. Cohn (Göttingen), Prof. Stainier (Gembloux), Prof. Schröter (Munich), Prof. Topinard (Paris), Dr. E. Dubois (Hague), Prof. C. Bohr (Copenhagen), Prof. Goldmann (Freiburg), Prof. Schimper (Bonn), Prof. Zacharias (Hamburg), and M. C. de Candolle (Geneva). As a number of others are still uncertain, and answers are now coming in every day, this can only be regarded as a provisional list. Probably the attendance of foreigners at this meeting will be unusually large. The Hospitality Sub-Committee is now busily engaged in arranging private hospitality for the foreign guests, and also for as many as possible of the home members of the Association who have intimated their intention of being present at the meeting.

W. A. HERDMAN.

THE DAVY-FARADAY RESEARCH LABORATORY.

SCIENTIFIC investigators have long needed a central laboratory where researches can be carried on without interruption, and have urged the establishment of a national physical laboratory for the United Kingdom. Twenty years ago the Duke of Devonshire's Commission recognised the advantages which our national industries would derive from physical and chemical investigations, and pointed out the need of a more generous recognition of such research by the State. Since then the Physikalische Reichsanstalt, at Charlottenburg, has been established, and, through the facilities it offers, Germany is reaping a rich harvest of natural knowledge; but, so far as State recognition is concerned, we have made little advancement. True, a Committee of the British Association has considered the question of a national physical laboratory, and another Committee is now reconsidering it; but there is no immediate prospect that any recommendations they might make will induce the Government to give a substantial grant, either for the extension of an existing institution in the direction of facilities for research, or for the establishment of an institution on the lines of the Reichsanstalt. For the perspicacity which sees in pure scientific research a means of developing industries, and which is content with knowledge accumulated, whether the practical bearings are apparent or not, we have to go to Germany, where many of our national industries have gone as a consequence of neglect by our Government.

Fortunately for British science, individuals occasionally arise who see how severely investigation is handicapped on account of the lack of organisation and encouragement by the State. One such benefactor is Dr. Ludwig Mond, whose munificent gift to the Royal Institution of a laboratory for physical and chemical research was warmly announced in these columns two years ago. We are now able to state that on June 12 Dr. Mond formally transferred to the managers of the Royal Institution the freehold of No. 20 Albemarle Street, adjoining that Institution, for the purpose of the laboratory of research in pure and physical chemistry referred to in our announcement, to be known as the Davy-Faraday Research Laboratory of the Royal Institution. In order to make the building suitable for this purpose, Dr. Mond has carried out very extensive alterations. He has also equipped the laboratory with the necessary apparatus, appliances, &c., for carrying on delicate investigations in physical and chemical science. An idea of the generous nature of Dr. Mond's endowment may be obtained from a statement of rooms included in the new institute.

The Laboratory contains:—

On the Basement.—A room for thermochemical research; a room for pyrochemical research; mechanics' workshop; room for electrical work; battery of twenty-six accumulators; constant temperature vaults; boiler-house and store-rooms.

On the Ground Floor.—A room for research in organic chemistry; a room for research in inorganic chemistry; a fire-proof room for experiments in sealed tubes; a balance room; entrance hall and cloak-room.

On the First Floor.—The Honorary Secretary's room; a large double library connected with the library of the Royal Institution.

On the Second Floor.—A museum of apparatus.

On the Third Floor.—Seven rooms for research in physical chemistry.

On the Fourth Floor.—A room for inorganic preparations; a room for organic preparations; a photographic room; four rooms for researches in physical chemistry.

On the Roof.—An asphalted flat with a table, gas and water.

All the floors are connected by a hydraulic passenger-lift.

Dr. Mond has not only furnished the laboratory with the most modern instruments and appliances for researches in pure and physical chemistry, but he has also placed in the hands of the managers of the Royal Institution an ample annual endowment, so that the laboratory may be maintained in a state of thorough efficiency, the object of the donor being to give every assistance and encouragement within the limits of the endowment to scientific workers.

The laboratory (the affairs of which will be managed by a Laboratory Committee appointed by the managers of the Institution) will be under the control of two directors, who will be aided in the work by competent assistants. The managers of the Royal Institution have appointed as directors Lord Rayleigh and Prof. Dewar.

It is intended to open the laboratory for work by the middle of October. The trust deed provides that no person shall be admitted to the laboratory as a worker who has not already done original scientific work, or in the alternative, who is not, in the opinion of the Laboratory Committee, fully qualified to undertake original scientific research in pure or physical chemistry; and that no person shall be excluded from admission by reason of his or her nationality or sex.

Admission to the laboratory, and the supply of gas, water and electricity, as far as available, will be free of charge; but any person using the apparatus, will be responsible for any damage done while in his possession.

Applications for admission are to be made to Mr. Robert L. Mond, Honorary Secretary to the Laboratory Committee, at 20 Albemarle Street.

The conditions of Dr. Mond's endowment are as liberal as the gift itself, and we have no doubt that the results which will follow will demonstrate the importance of both as means of advancing science. We regard the foundation of the laboratory as marking a most important step in the history of British science; for it provides a means whereby the edifice of scientific knowledge can be built up by master hands. British Governments are said to base their assistance to science mainly on the principle of helping voluntary effort. Perhaps, now that Dr. Mond has shown what can be done, the Government will show its interest in science by establishing a similar laboratory of a national character.

BORING A CORAL REEF AT FUNAFUTI.

LETTERS have just come to hand from Prof. Sollas stating that he has started from Sydney to carry out the project of putting down a boring through the atoll of Funafuti. By this time, if all has gone well, the expedition has probably started work.

It may be remembered that about six years ago, a strong committee was formed by the British Association, with Prof. Bonney as its chairman, and Prof. Sollas as secretary, "to investigate a coral reef by sounding and boring." The intention was to carry out the suggestion made by Darwin in his book on "Corals and Coral Islands," and to put to the test of fact the rival theories on the origin of these extraordinary limestone masses. After some years of preliminary thought and suggestion, a definite project began to take shape in 1894, when an application for a grant was made to the Government Grant Committee. The outcome of this was an application to the Admiralty for the service of a surveying vessel, which was most generously given for May of this year, and grants of money in aid were made by the Government Grant Committee and the Royal Society itself. A smaller executive committee of the latter body was formed, including the following names: Prof. Bonney (chairman), the President and Officers of the Royal Society, Mr. Wolfe Barry, Mr. Crookes, Mr. F. Darwin, Prof. Edgeworth David, Captain Field, Sir A. Geikie, Prof. Judd, Dr. J. Murray, Prof. Anderson Stuart, Admiral Wharton, with Prof. Sollas and Mr. W. W. Watts (secretaries), and preparations were concluded for making a start in time to leave Sydney in H.M.S. *Penguin* on May 1, under the command of Captain Field.

Meanwhile Prof. Anderson Stuart, of the University of Sydney, whose sympathy had been enlisted, entered warmly into the proposal. He took immense trouble in discussing with missionaries, sailors and travellers, the prospective merits of a large number of islands for the purpose of the investigation. Further he obtained from the Department of Mines in New South Wales the loan of a valuable set of diamond-drilling plant, and used his influence to overcome the natural difficulties which presented themselves in obtaining permission to use such apparatus on a waterless island in the Pacific. The committee is greatly indebted to this gentleman and to Mr. W. H. J. Slee, the Chief Inspector of Mines and Superintendent of Diamond Drills to the Government of New South Wales, for all the care and trouble they have taken in selecting the machinery and stores for this purpose, in engaging for the use of the expedition some of the most experienced foremen in the colony, and in obtaining a contribution towards the wages expense of the expedition.

Prof. Stuart's recommendation of the Island of Funafuti agreed with Admiral Wharton's knowledge of the island and the group to which it belongs, and it fortunately happened that further sounding and exploring of the group would furnish results of use to the Admiralty, so that a topographical and magnetic survey, together with sounding and current observations, could be carried on while the boring was being executed in the island.

Prof. Edgeworth David, from the University of Sydney, happened to be visiting England while preparations were in progress, and he furnished a most valuable means of communication with helpers in Sydney; and through this fortunate circumstance, the committee was able to come into closer touch with the Sydney committee in order to provide more completely for the regular work and such emergencies as could be foreseen. It was hoped that either Prof. David, or Mr. Pitman, the Government Geologist of New South Wales, would be able to take part in the expedition, but unfortunately neither gentleman could arrange to be away at the time requisite. Mr. Hedley, from the Australian Museum, has, however, been able to go, and he will utilise his opportunities for collecting and making observations in natural history.

Prof. Sollas, who is sent out by the committee in chief charge, will regard the boring work as the principal aim of the expedition, and will only be able to utilise his spare time in any other work. All of his observations, however, he intends to devote to the primary object of elucidating the structure and origin of the reef. It is therefore a good thing that Mr. Stanley Gardner, an enthusiastic Cambridge naturalist, has been able to accompany him, and he purposes to devote himself to biological work of such a nature as to bear directly on the origin and growth of reefs.

Funafuti is a typical atoll, submerged for the most part on its western side, but above water for a long strip on its eastern side. It is about fifteen miles in circumference and about seven miles in longest diameter, is one of a group of atolls situated due north of the Fiji group, and is about in latitude 10° S., and longitude 179° E. The

lagoon has a good entrance, and provides firm anchorage. There are about 400 inhabitants, with a native missionary and a white trader; but there is no good supply of water on the island.

Apparatus is being taken for boring about 1000 feet, but it is not anticipated that the bore will reach more than 700 feet in the time allotted, although three shifts will be working night and day, but not on Sundays, for the inhabitants are strict Sabbatarians. Delays are almost certain to occur, for the rock will be in places soft and cavernous, and the occasional dropping of the crown, resulting in probable injury to the diamonds, is not unlikely. For this reason the Department of Mines in New South Wales has provided steel cutters, which will be used whenever the nature of the rock permits it. The hole will start at four inches diameter, and it may be necessary in the later stages to drop to three inches, for which apparatus will be at hand.

The necessity for an investigation into the submarine structure of a coral reef is so well known to the readers of NATURE, that it is unnecessary to enter into any minute particulars. The explorers are instructed to bring back a core which will show what the under parts of a typical atoll are made of, and thus make known, what there has never been an opportunity of studying before, the foundations and under-structure of a reef which has not received sufficient uplift to clear the water. The different parts of this core will almost certainly indicate how its component rocks have originated—by living coral growing on coral *in situ*, on coral débris, on other types of organic rocks, or on a platform of denudation or deposition.

"Of the cores and of such other specimens as may be collected by the expedition (not referring to specimens collected by the volunteers in their private capacity), the first set will be ultimately presented to the British Museum, the second to the Ministry of Mines at Sydney."

In conclusion, I may be allowed to point out that though a large sum of money has been granted by the Government Grant Committee and by the Royal Society, it would have required very much more if the Admiralty had not made a most speedy and generous response to the request of the Royal Society. Even with that help, it would have been impossible to do the work so soon, or even probably at all, if further ready and kindly assistance had not been received from individuals mentioned above, and from the Department of Mines of the Government of New South Wales. The help thus rendered has probably reduced by three-fourths the total cost of the exploration, and it will be readily understood that the English committee feels a lively gratitude, not only to the Admiralty and its advisers, but to our good friends in New South Wales, amongst whom it is a pleasure to name Prof. Anderson Stuart, Mr. Slee, and Prof. Edgeworth David, not forgetting Sir Saul Samuel, the Agent-General of the Colony in England.

W. W. WATTS.

SIR JOSEPH PRESTWICH, D.C.L., F.R.S.

THE most eminent of British geologists has just passed away, and those who last Saturday stood around his grave amid the chalk hills of his pleasant country home at Shoreham, near Sevenoaks, felt that they were paying a last tribute to a veteran who had outlived all the associates of his prime, who had completed all his earthly tasks, and had gone to rest full of honours, and revered by all who knew him.

Joseph Prestwich was born in 1812 at Clapham, and after passing through elementary schools in London and in Paris, he proceeded to the famous grammar school of Dr. Valpy at Reading, and completed his education at University College in Gower Street. At this college his thoughts were directed to science by the lectures of Edward Turner on chemistry, and of Dionysius Lardner on natural philosophy. Turner, moreover, introduced the subjects of geology and mineralogy into his course, and thereby Prestwich gained those first lessons which aroused his interest and led him by force of circumstances to devote his leisure to geological studies. Had he been free to take up a profession he might, indeed, have given his special attention to chemistry. He was, however, destined to enter into commercial life, and until he was sixty years of age he was busily engaged in the city as a wine merchant. Assiduous and successful as a man of business, he yet contrived, from his earliest years in the office, to give great attention to geology, and he devoted all the leisure he could command to this subject, first of all as a means of relaxation, and finally because his interests were centred in the study. In early years his business-journeys enabled him to see and learn much about the general geology of England and Scotland; and when still a youth he spent his holidays during two successive years in studying the district of Coalbrook Dale in Shropshire, in mapping the various strata exposed at the surface from the Silurian rocks to the New Red Sandstone and Drifts, in marking the lines of fault, in noting in detail the character of the Coal-measures, and in gathering together the fossils from the several formations. The masterly memoir which he wrote on this area was communicated to the Geological Society of London in two portions in 1834 and 1836, being completed when the author was but twenty-four years of age. Meanwhile he had paid a visit to the north of Scotland, and had given some account of the Ichthyolites of Gamrie in Banffshire, a task which he undertook at the suggestion of Sir Roderick (then Mr.) Murchison. This was his first paper published in the *Transactions* of the Geological Society, of which he had been elected a Fellow in 1833.

Later on he came to devote his special attention to the Eocene formations in the neighbourhood of London, and in course of time he thoroughly investigated the entire area of the London Basin. In particular he defined and named the Thanet Sands and the Woolwich and Reading Beds; and he studied the sequence of organic remains in the London clay, and the subdivisions of the Bagshot series. In these researches he paid especial attention to the lithological changes of the strata and to their fossils, so that he could picture the physical conditions under which the several formations were deposited. He extended his observations into the Hampshire Basin, and showed that the Bognor beds formed part of the London clay, and eventually he proceeded into France and Belgium to correlate the subdivisions there made with those he had established in this country. This great work among the Eocene strata occupied much of his time for nearly twenty years, and it served to fully establish his reputation not only as a keen and accurate observer, but as a most philosophical geologist. Another great achievement soon awaited Prestwich, and that was the investigation of the valley gravels supposed to contain the works of man in association with extinct mammalia. Boucher de Perthes had in 1847 announced such discoveries in the Somme Valley, but they had received little attention. The somewhat similar discoveries in Kent's Cavern, by MacEnery, had likewise been neglected. Attention was, however, forcibly directed to the subject by the discoveries made in Brixham Cave in 1858, and Dr. Falconer then induced Prestwich to examine the evidence brought forward in the valley of the Somme. The results of these researches, which were carried on in conjunction with Sir John Evans, and which were followed by a study of the English evidence at Hoxne, in Suffolk, in the Ouse Valley, and elsewhere, are well known. The contemporaneity of man with the Mammoth and other Pleistocene mammalia was fully established,

and the antiquity of man came to be the most absorbing topic of the day. That vexed question still remains a matter under discussion, although Prestwich, in some of his later articles, has sought rather to reduce than to extend the time-limits of man's existence.

Subjects of practical importance from time to time engaged his attention. In 1851 he published "A Geological Inquiry respecting the Water-Bearing Strata of the country around London," a work which at once became the standard authority on the subject, and has lately been reissued with appendices. The author took a prominent part on the Royal Commission on Metropolitan Water Supply in 1867, and his services were again in request on the Royal Coal Commission, to the reports of which, published in 1871, he contributed accounts of the Bristol and Somerset Coal-field, and of the probable extent of Coal-measures beneath the Secondary rocks of the south and south-east of England. Agreeing generally with the conclusions of his friend Godwin-Austen, he was led to infer that concealed coal-fields might extend from Somersetshire eastwards to the neighbourhood of Folkestone. Subsequent explorations at Dover have shown the correctness of these theoretical views.

Prestwich was elected a Fellow of the Royal Society in 1853, and was appointed a Vice-President in 1870. In that same year he was chosen President of the Geological Society, and in the course of his two addresses he dealt with the subjects of deep-sea researches, and water-supply.

His attention had been given at various intervals to the later Tertiary deposits, and in 1871 his three great papers on the structure of the Crag-beds of Suffolk and Norfolk were published by the Geological Society. So much had been written by others on these very fossiliferous strata, that the author had not scope for so much originality as was the case with his Eocene researches. These later papers were, however, characterised by the same exhaustive treatment of the subject, in the record of many sections, and in the enumeration of the organic remains. His memoirs on the Pliocene or Crag formations were eventually followed by a series of articles dealing with more recent deposits. In the meanwhile Prestwich, who had retired from business in 1872, was offered the chair of Geology at Oxford, vacant through the death in 1874 of John Phillips. It came rather as a surprise to his friends that a man who had achieved such distinction and had earned repose should again go into harness. A young and ardent teacher would, however, at that time have been out-of-place, and, as events proved, no one better than Prestwich could have been selected to fill the post with such advantage to the University.

One result of his labours in Oxford was his large and handsomely illustrated work, in two volumes, entitled "Geology Chemical, Physical, and Stratigraphical"—a work in which he opposed the strictly uniformitarian teachings of some geologists, and urged that, though the agents were similar in kind in past ages, they were not similar in degree to those of the present day. Retiring from Oxford in 1888, Prestwich again surprised his many friends by his renewed activity. Paper after paper issued from his pen, dealing with the most difficult problems connected with the later superficial deposits—notably his memoir read before the Royal Society on the "Evidences of a Submergence of Western Europe and of the Mediterranean Coasts at the close of the Glacial or so-called Post-Glacial Period." He dealt also with the rudely-made plateau flint-implements of the Chalk Downs, many of them found near his Kentish home. Although individually they would not attract much notice, he maintained that these rudely-chipped flints bore traces of human workmanship, and collectively showed evidence of a peculiar type of earlier date than the ordinary Palæolithic implements.

These later writings of Prestwich have initiated many new lines of inquiry, even if they have failed to carry conviction to all his readers.

The last honour bestowed upon him, in the early part of this year, was that of knighthood, which he was unable to accept in person from Her Majesty owing to his feeble health. He died on June 23, at his home, Darent Hulme, near Shoreham. H. B. W.

NOTES.

The Albert Medal of the Society of Arts has been awarded, with the approval of H.R.H. the Prince of Wales, the President of the Society, to Prof. David Edward Hughes, F.R.S., "in recognition of the services he has rendered to arts, manufactures, and commerce by his numerous inventions in electricity and magnetism, especially the printing telegraph and the microphone."

The Swiss Society of Electrical Engineers is organising an International Electrical Congress, which is to take place at Geneva from August 4 to August 9 next, under the presidency of M. Turrettini. The following subjects are to be discussed at the Congress: (1) Magnetic Units, (2) Photometric Units, (3) Transmission and Distribution of Power to Great Distances by means of (*a*) Direct Currents, (*b*) Alternate Currents, (4) Protection of High-pressure Overhead Electric Lines against Atmospheric Discharges, (5) Various Disturbances caused by Electric Traction. Further information can be obtained from the Bureau du Congrès International des Électriciens, Université, Genève.

It has been proposed that some token of esteem be presented to Prof. N. Story-Maskelyne in recognition of his distinguished services to mineralogical science, and to commemorate his long connection with the University of Oxford. The presentation is intended to take the form, if possible, of a portrait, and it is believed that contributions not exceeding £2 in amount will be sufficient for the purpose. A number of men of science, both at home and on the continent, have already promised their support. Contributions will be received by Prof. A. H. Green, F.R.S., or Prof. H. A. Miers, F.R.S., University Museum, Oxford.

The Board of Managers of the New York Botanical Garden have issued the first number of a *Bulletin*, containing the Act of Incorporation, and a map of the site for the Garden granted by the Commissioners of Public Parks. By agreement with the Trustees of Columbia College, the botanical library and herbarium belonging to that institution will be deposited in the Botanical Garden. The endowment fund of 250,000 dols. required by the Act of Incorporation has now been fully subscribed. The President of the Board of Managers is Mr. Cornelius Vanderbilt; the Secretary, Prof. N. L. Britton.

Mr. Austin Corbin, who was killed a few days ago in New Hampshire, had acquired a herd of fifty buffalo, which he kept in his preserves in that State. It was his intention to lend the animals for an indefinite period to the city of New York, and a plot of eighty acres in Van Cortlandt Park, in the northern (annexed) portion of the city, had been prepared for them, having been surrounded by a fence seven feet high. The plan will be carried out by his representatives, and the herd will be moved in the autumn; the delay being caused by apprehension that change of climate during hot weather might prove pernicious. This measure may avert the threatened extinction of the buffalo, which has now been almost extirpated on the western plains.

Mr. J. H. T. Tudsbery has been appointed Secretary of the Institution of Civil Engineers, in succession to Mr. James Forrest, who has retired.

A REUTER telegram from St. Petersburg says:—"Despatches from Irkutsk announce that M. Hansen, the Norwegian trader, left that town on June 1 for the north of Siberia. His journey is primarily for trading purposes, but he will also inquire into the truth of the recent rumours regarding Dr. Nansen, and see if the store of provisions left by Baron Toll in the New Siberian Islands for Dr. Nansen is still intact. M. Hansen's mission has been confided to him by the Russian Imperial Geographical Society."

THE cruellest deed committed for the gratification of feminine vanity is the destruction of small white herons or egrets, during the season in which they have their nests and young, in order to supply plumes for ladies' hats. By persistent appeals the Society for the Protection of Birds have induced a small proportion of the gentler sex to give a thought to the conditions under which their borrowed plumes are obtained, and a slight feeling against the fashion of wearing feathers has been aroused. But fine feathers are so essential to feminine decoration, that the slightest excuse is sufficient to salve the conscience. Happy were the ladies, therefore, when they were told by shopkeepers that lovely delicate plumes for the decoration of hats were now artificially made, and no peculiar cruelty was necessary to obtain them. But their complaisance has been disturbed. Sir William Flower has examined numbers of plumes, the wearers of which were priding themselves on their humanity, trusting to the assurance of the milliner that they were not real egret's feathers, but manufactured, and he has found in every case that they were unquestionably genuine. The only "manufacture" consisted in cutting the plume in two, and fixing the upper and lower half side by side, so that a single feather does duty for two in the "brush." Simply to keep up their trade and dispose of their stock, the purveyors of female raiment have invented and widely propagated a monstrous fiction, and are everywhere selling the real feathers warranted as artificial! "Thus," concludes Sir William Flower, "one of the most beautiful of birds is being swept off the face of the earth, under circumstances of peculiar cruelty, to minister to a passing fashion, bolstered up by a glaring falsehood."

IN order to determine the highest possible speed that may be attained on railways, trial runs were lately made between Berlin and Lübbenau on the Berlin and Görlitz line, states the *Engineer*; and for these runs a special express engine of new design with four cylinders and driving wheels of 2 metres (6ft. 6in.) diameter has been constructed, thus giving the engine a much greater height above the rails than usual. The composition of the trains was very various, amounting sometimes to 100 axles. With a train of 30 axles the highest performance, viz. 106 kiloms. ($65\frac{3}{4}$ miles) per hour was recorded, being 20 kiloms. (12 miles) more than the highest speed hitherto attained by the quickest German lightning train (Blitzzüge), viz. the Berlin Hamburg D-Zug, which runs through a distance of 286 kiloms. ($177\frac{1}{2}$ miles) in $3\frac{1}{2}$ hours, while the speed of ordinary German expresses is only 70 kiloms. ($43\frac{1}{2}$ miles) per hour. The portions of lines chosen for the runs were tolerably horizontal over their whole length, and had very few curves.

OUTBREAKS of anthrax are by no means easy to trace to their fountain-head; and the Canton of Zürich has recently been much exercised over the appearance of anthrax in a district where this disease had previously been unknown. Dr. Silberschmidt, one of the assistants of the Hygienic Institute attached to the University of Zürich, has been entrusted with the task of ferreting out, if possible, the means by which anthrax has been introduced. Suspicion had fallen upon a horse-hair factory in the vicinity of the infected area, where the raw material employed emanated principally from Russia, from which country it is imported direct *viâ* Leipzig, in large bundles weighing over a hundredweight. These bundles are subjected to no process whatever of sterilisation or cleansing; and as cases of anthrax, whilst rarely met with amongst horses in Switzerland and other European countries, are comparatively frequent in Russia, the suspicion of this factory being the probable source of the trouble seemed justified. Careful examinations of some of this horse-hair, and also of the dust in the factory, revealed the undoubted presence of anthrax germs; thus the dissemination of anthrax appeared to be readily accounted for, and its distribution in the spore form as dust, in consequence of the extraordinary vitality of anthrax spores, renders it a particularly dangerous foe to deal with. It has been suggested to the authorities that Russian horse-hair should be sterilised on the frontier, or at any rate in Leipzig, in special apparatus arranged for the purpose, as, after the raw material has been distributed to small factories, the expense of sterilisation renders its being successfully carried a matter of great difficulty.

THE vexed question in the theory of fluid friction, whether finite slipping does or does not take place at the surface of a solid in contact with a liquid, forms the subject of a contribution, by Dr. Antonio Umani, in a recent number of the *Nuovo Cimento*. The experiments were conducted in the physical laboratory of the University of Parma, the apparatus used consisting of a cylindrical box filled with mercury, and suspended by a torsion fibre. In one series of experiments the sides of the box were nickel-plated, so that the mercury did not actually wet the metal; in another series, the mercury was made to bathe the sides of the box by thoroughly amalgamating the latter. In the former case, the presence of a film of air between the mercury and nickel was obviated by filling the box *in vacuo*. The observed values for the logarithmic decrement of the amplitude of the oscillations were found to differ in the two series of experiments by an amount which, Dr. Umani considers, indicates finite slipping between the mercury and the box when the latter is nickel-plated. The author further proceeds to calculate the internal coefficient of viscosity of mercury from the results of his second series of experiments, and obtains the value $\eta = 0{\cdot}01577$ C.G.S. units at temperature 10° C. Warburg, employing Poiseuille's method, had previously obtained at temperature 17°·2 C. the value 0·01602.

IN the *Bulletin* of the Royal Academy of Belgium, M. Léon Gerard contributes the results of some observations on the seat of emission of Röntgen rays, and their mode of propagation in air. The rays emanating from a Crookes' tube were allowed to pass through three diaphragms, and the emergent pencil of light was received on a photographic plate placed in different positions, so as to give both transverse and oblique sections of the pencil. By comparing these various sections, M. Gérard has been led to the conclusion that Röntgen's statement, according to which air is much less absorbent to Röntgen rays than to kathodic rays, is inexact. He considers that both kinds of rays possess the analogy of not travelling exactly in straight lines, and that, in accordance with the views of Lénard, atmospheric air is a turbulent medium for kathodic manifestations, and that their transmission takes place as in a turbulent medium, such as stearin or milk. M. Gérard's second conclusion, namely, that Röntgen rays only emanate from the surface of the glass on which kathodic rays fall, is in accordance with the numerous investigations described in previous numbers of NATURE.

THE action of Röntgen and other rays on the higher animals has been studied by Prof. Stefano Capranica (*Atti R. Accad. dei Lincei*). The subject selected for observation was *Mus musculus*, and the experiments referred chiefly to the quantity of carbon dioxide exhaled in the process of respiration. Prof. Capranica states the following conclusions: (1) The amount of CO_2 is the same in darkness as in diffuse daylight. (2) The

respiration of *Mus musculus* is greatly affected by strong sunlight, even when all heat-rays have been screened off; and the effect is the same for rays from all parts of the spectrum. (3) Artificial lights, such as the electric light or incandescent gas, act like sunshine when concentrated on the animals, but have no effect when merely used to light a room. (4) The light from Geissler's tubes has no effect. (5) Röntgen rays have no action on the quantity of CO_2 eliminated from the animal, whatever be the conditionof the latter; that is, whether fasting or after feeding, whether previously kept for several hours in darkness, or *vice versâ*. (6) What was observed with each of the six moles experimented on was strong excitement, which continued for several hours after the experiments with Röntgen rays had ceased. The moles, after being exposed to Röntgen rays for one hour, ran about in a nervous and excited way, and would not eat. (7) This excitement Prof. Capranica attributes to the electrical effects of the Röntgen rays. (8) Experiments on cold-blooded animals (*Coronella*) give, as yet, no appreciable results.

THE meteorological and astronomical work accomplished during 1895 in the Observatory of the Mersey Docks and Harbour Board, are stated by Mr. W. E. Plummer in a report just received. Appended to the general tables is a catalogue and short discussion of all the gales of wind that have been automatically recorded with velocities equal to, or exceeding, fifty miles per hour. Several interesting points are brought out by the catalogue. It appears that the average length of a storm at Liverpool, as defined by the condition that the wind velocity shall exceed fifty miles per hour, is about six hours; while the average number of stormy hours in a year does not greatly exceed sixty. With regard to the time of year in which these disturbances occur, general experience points to a connection between them and the observed temperature. This agreement is very clearly shown by Mr. Plummer in a diagram having a curve exhibiting the number of stormy hours in each month, and an inverted temperature curve. The two curves very markedly coincide with one another. By means of two other diagrams Mr. Plummer shows the connection between barometric height and wind velocity; the variation of the barometer being taken from the time when no indications of a gale were apparent to the time when the disturbance ceased. There is a distinct difference between these variations and the wind velocity in the cases of winter and summer storms. In the winter, the fall of the barometer coincides with some approximation to the increase in the severity of the storm, but on the average the time of minimum barometer precedes the time of maximum velocity by about four hours. The mean length of time from the beginning to the end of the storm is twenty-six hours, of which twelve are occupied in the increase, and fourteen in the decrease of violence. The rise in the barometer after the time of maximum velocity is more marked than in the fall, and the mercury stands considerably higher at the end than at the beginning In the summer, the average length of time embracing the whole of the disturbance is reduced to twenty-two hours. The fall of the barometer as the storm gathers force is very slight, and on the average only amounts to 0·04 inch, while the minimum barometer occurs five hours before the maximum wind velocity. In nearly half the storms examined the barometer rose steadily throughout the whole of the disturbance. Mr. Plummer could find no instance of a storm occurring in the summer months when the barometer stood above 30 inches: in winter, 10 per cent. of the storms were developed at that pressure.

THE seventh volume of the *Geographical Journal* (new series), containing the monthly numbers from January to June of this year, has been published with commendable promptitude. The volume is a wonderfully interesting record of travel and discovery, and, with its notes, descriptive lists of geographical literature, new maps, and illustrations, it is an invaluable publication to geographers.

A SERIES of sixteen reproductions of photographs obtained by means of Röntgen rays, together with text (in Japanese) explanatory of the methods by which they were obtained, has been received from Prof. Y. Yamaguchi and T. Mizuno, of Tōkiō University. The photographs are much less distinct than those obtained since the introduction of the focus tube, but they nevertheless show that Japan means to keep in the van of scientific progress.

A CONTRIBUTION to the theory of warning colours and mimicry appears in the *Journal* of the Asiatic Society of Bengal (vol. lxv. Part ii. No. 1, 1896). Mr. Frank Finn, Deputy Superintendent of the Indian Museum, has tested the taste of the common garden lizard of India (*Calotes versicolor*) for various insects, and especially for butterflies protectively coloured and plain. Mr. Finn thinks the behaviour of the reptiles at liberty does not afford support to the belief that the butterflies, at any rate, usually considered nauseous, are distasteful to them.

WE understand that the next instalment of the "System of Medicine," which Prof. Clifford Allbutt is editing for Messrs. Macmillan and Co., will deal with Gynæcology, and will appear in the course of September. Dr. Playfair is associated with Prof. Allbutt as editor of this volume, which, though uniform with the system, will be complete in itself. The second volume of the "System of Medicine" proper may be expected by the end of the year. Messrs. Macmillan and Co. will also shortly issue a work on "Deformities," by Mr. A. H. Tubby. It is a comprehensive treatise on orthopædic surgery, and is fully illustrated by two hundred original plates and figures, and notes of one hundred cases.

THE June number of the *Journal* of the Chemical Society is an exceptionally bulky one; it runs into nearly four hundred pages, seventy-five of which are taken up with abstracts of papers. A distinguishing feature of the number are the four detailed accounts contained in it of Hofmann and his work. These are:—"Personal Reminiscences of Hofmann and of the conditions which led to the establishment of the Royal College of Chemistry and his appointment as its Professor," by Lord Playfair; "The History of the Royal College of Chemistry and Reminiscences of Hofmann's Professorship," by Sir F. A. Abel; "The Origin of the Coal-Tar Colour Industry, and the Contributions of Hofmann and his Pupils," by Dr. W. H. Perkin; and "Notes on Hofmann's Scientific Work," by Dr. H. E. Armstrong. Students of chemistry will find these descriptions full of interesting personal reminiscences, and will derive from them an idea of the marvellous amount of work which Hofmann accomplished.

THE Lepidoptera collected in Eastern Africa by Dr. W. L. Abbott have been determined by Dr W. J. Holland, and a list of them, with some other collections, is given in an excerpt from the *Proceedings* of the U.S. National Museum (vol. xviii pp. 229-279). The collection from Eastern Africa was found by Dr Holland to contain only a small number of species new to science, the great majority being species well known from other localities, and noticeably from temperate South Africa, many of them species named in the last century. It is pointed out that the presence of an *Argynnis* and a *Chrysophanus* in the collection is peculiarly interesting, and suggests to the student the thought that when a more thorough exploration of the lofty heights of Kilimanjaro, Kenia and Ruwenzori shall have been made, there will be some very remarkable, if not astonishing, facts brought to light as to the geographical distribution of animals. A collection made by Dr. Abbott in the islands lying west and north of Madagascar in the Indian Ocean, also possesses interest as illustrating the geographical distribution of genera

and species. Dr. Holland finds it to be made up of certain genera possessing great capabilities for migration, and apparently a strong power to resist change under varying conditions. The other collections of Lepidoptera described by Dr. Holland in the excerpt referred to, were obtained from Somaliland, by Mr. W. A. Chanler and Lieut. von Hoehnel; and from Kashmir, by Dr. Abbott.

The Connecticut Agricultural Experiment Station was established in 1877 "for the purpose of promoting agriculture by scientific investigation and experiment." The nineteenth annual report, containing an account of the work carried on during 1895, shows that both the science and practice of agriculture are advanced by the researches at the Station. The papers on the agricultural value of fertilisers and the availability of nitrogen alone furnish the materials for a liberal education in agriculture. Hundreds of analyses have been made in the chemical laboratory, while diastase—the sugar-forming ferment of sprouting seeds—and the proteids of the potato, malt, pea, vetch, and other plants have been studied, and new results obtained with reference to them. Experiments on the efficacy of the corrosive sublimate treatment of potato seed, where the land which is planted with potatoes is already fully infested with the potato-scab fungus, showed that the treatment was of little avail in preventing scab upon the crop. It was found that the addition of lime in quantities to the soil of the experimental field increased the amount of scab. The dreaded San José scab appeared in Connecticut for the first time in 1895, and great credit is due to the State Experiment Station for the prompt and thorough manner in which they gave nurserymen information regarding the occurrence, characteristics, and life-history of the insect, and the methods which have proved successful in eradicating it. Many other matters occupied the attention of the staff of the Station during the year covered by the report, and the results have been made known to the farmers of Connecticut. All the work proper to the Station that can be used for the public benefit is done without charge. Further, we read: "Every Connecticut citizen who is concerned in agriculture, whether farmer, manufacturer, or dealer, has the right to apply to the Station for any assistance that comes within its province to render, and the Station will respond to all applications as far as lies in its power." This announcement is sufficient guarantee that the Station is never in want of subjects for investigation, and the *Bulletins* and Reports published from time to time testify to the great value of the work undertaken and results obtained.

The additions to the Zoological Society's Gardens during the past week include three Indian Stock Doves (*Columba eversmanni*), a —— Duck (*Nyroca baeri*), three —— Hemipodes (*Turnix dussumieri*) from India, presented by Mr. Frank Finn; a Peba Armadillo (*Tatusia peba*) from South America, eight Bell's Cinixys (*Cinixys belliana*) from Angola, a Maximilian's Terrapin (*Hydromedusa maximiliana*) from Brazil, a Madagascar Boa (*Pelophilus madagascariensis*), a Madagascar Tree Boa (*Corallus madagascariensis*) from Madagascar, deposited; two Plantain Squirrels (*Sciurus plantani*) from Java, an Occipital Vulture (*Vultur occipitalis*) from Africa, two Burmeister's Cariamas (*Chunga burmeisteri*) from the Argentine Republic, two Crowned Partridges (*Rollulus cristatus*) from Malacca, twelve Spotted Tinamous (*Nothura maculosa*) from Buenos Ayres, two Chilian Teal (*Querquedula creccoides*) from Antarctic America, two Shamas (*Cittacincla macrura*), a Malabar Green Bulbul (*Phyllornis aurifrons*) from India, a —— Sand Snake (*Psammophis schokari*), a Hissing Sand Snake (*Psammophis sibilans*) from Egypt, purchased; a Brush-tailed Kangaroo (*Petrogale penicillata*), two Spotted Pigeons (*Columba maculosa*), two Triangular-spotted Pigeons (*Columba guinea*), two Vinaceous Turtle Doves (*Turtur vinaceus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

Declinations of Fifty-six Stars.—The definitive declinations and proper motions of fifty-six stars have been determined at the Columbia College Observatory (*Contributions*, No. 8). The stars in question were selected by Profs. Fergola and Jacoby for observation at Naples and New York by the Talcott method, for the determination of the variation of latitude, and for the calculation of the constant of aberration by Küstner's method. Prof. Jacoby commenced the investigation, but ill-health compelled him to relinquish it, and it was continued by Mr. Davis. The discussion of the declinations was undertaken with the object of obtaining results based upon all available observations, so as to make this part of the work of value as an independent research. The memoir involves observations recorded in no less than 130 star catalogues, and represents an enormous amount of painstaking computation.

Graphical Prediction of Occultations.—The usual methods of deriving the local circumstances of an occultation, either graphically or by calculation, are somewhat lengthy and tedious, but a new construction, described by Major Grant, R.E., in the June number of the *Geographical Journal*, is rapid, simple, and sufficiently accurate for most purposes. With the aid of a convenient diagram the parallaxes in declination and right ascension of any heavenly body are readily determined, and when applied to the moon the elements of an occultation are easily deduced. It is stated that after a little practice the whole process can be performed in about twenty minutes, and that, with moderate care, the error of the time of disappearance or reappearance should not exceed ten minutes, while the angles of ingress and egress need not differ more than one or two degrees from those calculated. Separate copies of the paper, with the diagrams suitably mounted, can be obtained on application to the Royal Geographical Society.

Mass of the Asteroids.—In a paper under the title of this note (*Ast. Nach.*, No. 3359), G. Ravené attempts to determine the most probable mean value of the total mass of the minor planets, on the basis of the secular perturbations of the perihelion point of Mars. The best result given in Newcomb's recent work on the subject (*Bull. Ast.*, xiii., January 1896), shows that the perihelion motion of Mars is not entirely that given by theory, unless an empirical amount of about $5''.55$ in a century be taken into consideration. It is obvious that at least part of these perturbations may be attributed to the disturbing force of the minor planets, and this is rendered more probable when Barnard's recent measures of the diameters of the four chief asteroids are taken into account. From these it was concluded that the asteroids are by no means so small as the previous photometric measurements had indicated, and it is not certain that such data are useful for a precise estimate of the mass of these small bodies.

An asteroid like Ceres, having a diameter of about 485 miles, will have a mass of about 1/4000th part of the earth's mass, if we assume it to have an equal density. It is thus quite likely that in a considerable length of time the total mass of all the asteroids will be sufficient to cause appreciable perturbations of the elements of a neighbouring planet.

In considering the theory of this action, it is assumed that the asteroids are distributed in an elliptical ring round the sun, and by noting the excess of perturbation produced on neighbouring bodies, using Gauss's method for calculating secular perturbations, the mean mass of the ring is found to be $= 1/37,130,000$ the sun's mass, or $= 1/115$ the earth's mass.

Variable Stars.—Harvard College Observatory *Circular*, No. 7, gives particulars of the discovery of seven new variables, and also of the confirmation of variability in three stars previously suspected by other observers. Three of the variables have spectra of the *third* type, showing also bright hydrogen lines. Three others have spectra of the *fourth* type. The star $-33°$ 14076 was found to be variable by Colonel E. E. Markwick, of Gibraltar, but no photographic confirmation was obtained until Mrs. Fleming ascertained that a star having a peculiar spectrum was identical with this. Detailed examination of all the plates of this region, eighty-nine in number, then showed it to vary in magnitude from 11·3 to 6·4. The spectrum of the star has bright lines which show evidence of change.

A large number of observations has been made with the meridian photometer to determine the forms of the light

curves of variable stars of the Algol type. S. Antliæ has usually been regarded as belonging to this class, and is specially interesting on account of its short period of 7h. 46·8m., and because it is said to retain its full brightness for *less* than half its period, this last peculiarity being opposed to the probability of the variation being due to a dark eclipsing body. On constructing a curve from a series of 177 measures, the conclusion is that S. Antliæ is not a star of the Algol type, but its light is *constantly* changing, and that it should rather be classed among the variables of the δ Cephei or η Aquilæ type. An interesting feature of the light curve for this star is that the increase of light is slower than the diminution. As this ratio (0·62) in most other short-period variables is from 0·20 to 0·33, there seems reason for dividing the two classes.

The star β Lyræ is commonly regarded as a variable of short period of the same class as the above. "Observations of its spectrum, however, show that two or more bodies, revolving round each other, are present. The light curve found by Argelander may be closely represented by assuming that the primary minimum is caused by the eclipse of the brighter body by the fainter, and the secondary minimum by a similar eclipse of the fainter body by the brighter. This star should therefore be taken from the class of ordinary short-period variables and included among the stars of the Algol type." Lockyer finds, however, that there is evidence of greater complication in the system; and the theory of eclipses alone fails to account satisfactorily for the velocities in the line of sight which are obtained from the measurements of photographs of the spectrum of the star.

AWARD AND PRESENTATION OF THE RUMFORD PREMIUM.

IN conformity with the terms of the gift of Benjamin, Count Rumford, granting a certain fund to the American Academy of Arts and Sciences, the Academy is empowered to make, at any annual meeting, an award of a gold and silver medal, being together of the intrinsic value of three hundred dollars, as a premium to the author of any important discovery or useful improvement in light or in heat, which shall have been made and published by printing, or in any way made known to the public in any part of the continent of America, or any of the American islands; preference being always given to such discoveries as shall, in the opinion of the Academy, tend most to promote the good of mankind.

At the annual meeting of 1885, the Academy awarded the Rumford premium to Thomas Alva Edison for his investigations in electric lighting, and the presentation of the medals took place at the meeting of May 13, 1896.

Vice-President Goodale, in presenting the medals, made the following remarks:—

"It would be highly presumptuous for one whose knowledge of physics is of the most elementary character to occupy the time of the Academy by any statement of his own in conveying these medals. Happily such a course is unnecessary. The Chairman of the Rumford Committee has placed at our command a brief statement which makes clear the ground of the award.

"'The Rumford Committee voted, June 22, 1893, that it is desirable to award the Rumford medal to Thomas Alva Edison in recognition of his investigations in the field of electric lighting, and they confirmed this vote on October 9, 1893, in the following words: "Voted for the second time to recommend to the Academy that the Rumford medal be awarded to Thomas Alva Edison for his investigations in electric lighting."

"The Committee reached the conclusion expressed by these votes after long deliberation and after careful sifting of all the evidence which was at their disposal in regard to Mr. Edison's claim for priority in the construction of the incandescent lamp, the conception of the central lighting station together with the multitude of devices, such as the three-wire circuit, the disposition of the electric current feeders, and the necessary methods for maintaining the electric potential constant.

"The Committee felt that they could not decide upon Mr. Edison's claim for priority in any particular invention in this new industry. Indeed, Courts of Law, after prolonged litigation, have found it difficult to decide how far Mr. Edison was in advance of contemporary workers. The task given to the Rumford Committee to decide who is most worthy of the Rumford medal, especially in the field of the application of electricity for the production of light and heat, is not an easy one. The number of investigators is now so large that it is no longer possible, in general, for one man to claim to be the first to apply electricity to a new field. The successful application is the result of many minds working on the same problem. Although the Committee did not feel justified in expressing the opinion that Mr. Edison invented the incandescent carbon filament lamp, or that he was the first to arrange such lamp in multiple on the circuit, thus producing what is popularly termed a subdivision of the electric light, or that the Edison dynamo had greater merits than the machine of Gramme and Siemens and others; still, they are convinced that Mr. Edison gave a great impulse to the new industry, and that he was the first to successfully instal a central electric lighting plant with the multitude of practical devices which are necessary. They believe that this impulse was due to his indefatigable application, to his remarkable instinct in whatever relates to the practical application of electric circuits, and to his inventive genius. They, therefore, have unanimously recommended to the Academy to bestow the Rumford medals upon him, feeling that the work of Mr. Edison would especially appeal to the great founder of the medals—Count Rumford—if he were living.

"The Academy has accepted the report of the Rumford Committee, and has voted to confer the gold and the silver medal upon Mr. Edison. The recipient finds it impossible to be present at this meeting of the Academy, and has requested Prof. Trowbridge to act as his proxy and to receive the medals for him.

"In the name of the Academy, I beg you, Prof. Trowbridge, to accept the charge of conveying these medals to Mr. Edison's hands. It would be most ungracious for us who are assembled in this room, which is flooded by this steady and brilliant electric light, to withhold our personal thanks for what Mr. Edison's investigations and practical activities have done for us all. And, hence, I may venture to say that our thanks and all good wishes are to be conveyed with the Rumford medals."

Prof. Trowbridge replied as follows:—

"Mr. President, and gentlemen of the Academy, I accept the medals for Mr. Edison; and at his request I wish to express his deep sense of the great honour the Academy has conferred upon him. His work in the field of electric lighting has been the subject of prolonged litigation, and at times he has had doubts, in reading the opinions of learned experts, whether his work has been original, or whether he had really contributed anything to the world's progress. The recognition of his labours by the American Academy of Arts and Sciences, regarded by Count Rumford in his gifts as the coequal of the Royal Society of London, is, therefore, especially grateful to him. Acting as his proxy, I thank the members of the Academy for the distinction which they have, by their votes, conferred upon him."

CAUSES OF DEATH IN COLLIERY EXPLOSIONS.

A REPORT, by Dr. John Haldane, on the causes of death in colliery explosions, with special reference to the Tylorstown, Brancepeth, and Micklefield explosions, was published in a Blue-book a few days ago. The report contains a vast amount of valuable information on the composition of after-damp, the action on men and lights of the gases present in, or mixed with, after-damp, the action of after-damp, heat and violence, along the track of an explosion, the distribution of after-damp and other gases in a mine after an explosion, the distribution of smoke in underground fires, the positions at which bodies are found after an explosion, and the means of saving life in colliery explosions and fires. To understand the dangers to life after a colliery explosion, and the possibilities of escaping these dangers, it is necessary to have a clear idea of the action, both on men and lamps, of the gases which are likely to be present in the air of the mine. These gases, so far as is known, are carbon dioxide, carbon monoxide, nitrogen, fire-damp, and sulphurous acid. Oxygen may be deficient or absent. Dr. Haldane discusses the effects of these gases *seriatim*, and the information he brings together, as well as his own careful observations, should be valued by colliery managers, while it will certainly interest chemists and physiologists.

In the case of the Tylorstown explosion, which, Dr. Haldane says, was evidently propagated through the three pits by coal-dust, fifty-seven men were killed. Of this number fifty-two, or 91

per cent. of the whole, were killed by after-damp, the remainder being killed instantaneously by violence. In nearly every case of death from after-damp, the parts of the skin or mucous membrane through which the colour of the blood could be observed, had a red or pink colour, instead of being leaden-blue or pale, as is the case in death from any other cause. This reddening, as seen in the face, hands, &c., often gave the bodies an extraordinary appearance of life. There seemed to be only one cause which could account for the carmine red colour of the blood, namely, the presence of carbon monoxide. To make certain, Dr. Haldane examined the blood from two of the bodies on the spot, by means of a spectroscope, and he found that not only was carbon monoxide present, but that the hæmoglobin was nearly saturated with it. A quantitative determination proved that in both bodies the hæmoglobin was 79 per cent. saturated. This result is of special interest, as it shows, for the first time, the percentage saturation of the blood at the moment of death from carbon monoxide poisoning.

The recognition of carbon monoxide in the air of mines is, as Dr. Haldane points out, a matter of much practical importance, and many lives have been lost through ignorance of the fact that the lamps, to which miners trust for the recognition of other gases, give no *direct* indication of carbon monoxide. A simple test, which there is every reason to think might be successfully introduced, is suggested: it is to observe the symptoms of a mouse or other equally small warm-blooded animal, when exposed to the doubtful atmosphere. In small animals the rate at which the blood becomes saturated with carbon monoxide is far more rapid than in man; hence a small animal, such as a mouse, shows the effects of the gas far more rapidly than a man. Practically speaking, the condition of a mouse which has been for a very short time in a poisonous percentage of carbon monoxide, indicates what will be the condition of a man carrying it after a much more prolonged stay in the same atmosphere. With a man at rest it takes about twenty times as long for the man as for the mouse to be distinctly affected by the gas. Dr. Haldane's experiments show distinctly how valuable the indications given by a mouse, or other small animal, would be to men exposed to danger from after-damp. It is therefore suggested that a few white mice might easily be kept for this purpose in the engine-room at the top of the downcast shaft, and be taken down in small cages by the rescue party.

Another point to which attention may briefly be directed is the colour-test described by Dr. Haldane for use in post-mortem examinations as a criterion for carbon monoxide poisoning. A drop of the blood of the subject is diluted with about 100 times its volume of water, and is compared with a solution of normal blood, and with a similar solution saturated with coal-gas. According to the percentage saturation of the sample of blood under examination, the tint of the first solution will approach to that of the normal blood, or of the blood saturated with coal-gas (that is, with carbon monoxide), and a rough estimate may be made of the percentage saturations. The test is said to be more delicate than that with the spectroscope.

INDIVIDUALITY IN THE MINERAL KINGDOM.[1]

IT might be expected of a new Professor that in his inaugural address he should avail himself of the possibly unique opportunity of an audience, and should give some account of his science and of the manner in which he proposes to teach it. In that case he would doubtless claim for his own subject that it is the most fascinating and the most important of all branches of human knowledge; he would doubtless, also, proceed to prove, to his own satisfaction, that it should be a necessary feature in any system of education.

It is well known that every specialist has an exaggerated view of the importance of his own subject; a view which is no doubt largely due to his ignorance of all others. I am deeply conscious of sharing this failing, and therefore do not propose to give any laboured account of mineralogical science; instead of stating exactly what in my opinion should be taught in this university, I will rather state presently what I think should not be taught; instead of attempting to *prove* that mineralogy possesses a true educational value, I will assume that this may be accepted without further argument from the very fact that it is recognised by the University.

[1] An inaugural lecture delivered at the University Museum, Oxford, by Henry A. Miers, F.R.S., Waynflete Professor of Mineralogy.

Perhaps none of the sciences is more of a special subject than mineralogy, in this sense—that it is familiar to few besides those who have made it their particular study; for this reason I may be pardoned if I assume total ignorance on the part of my hearers, and begin by removing a confusion which may possibly exist in the minds of many.

Mineralogy is not crystallography. Mineralogy is the study of minerals in all their relations, and from every point of view; it is a branch of natural history; the study of one class of natural objects, namely, all the inorganic parts of the earth, which we are accustomed to class together as the Mineral Kingdom. Crystallography, on the other hand, is a distinct science, and is the study of matter in the crystalline state, not being by any means confined to minerals; it is, like physics, or chemistry, or geology, one of the sciences whose aid is invoked in the study of minerals.

Since, however, the finest and most interesting examples of crystals have been found in the mineral kingdom, this study has been, by common consent, annexed by the mineralogist, and instruction in crystallography has been left entirely to him. The result has been in some ways disastrous; crystallography is in reality as essential to the student of chemistry or of physics as it is to the mineralogist, and yet remains in general a sealed book to them. They have been reluctant to go to the mineralogist for information, and consequently they have failed to make the acquaintance of crystallography. In this connection I may quote the forcible words of Mr. Lazarus Fletcher: "It seems obvious," he says in an address delivered a few years ago, "that in a satisfactory system of education every chemist should be taught how to measure and describe the crystalline characters of the products which it is his fate to call into existence. A knowledge of the elements of crystallography, including the mechanics of crystal-measurement, ought to be made a *sine quâ non* for a degree in chemistry at every university."

To this I would add that crystallography is not merely a matter of theoretical interest to the chemist, but is absolutely essential for the practical determination and description of any compound. It will scarcely be believed that there is only one teaching institution in the British Isles where crystallography forms a necessary part of the chemical student's course, namely the Central Technical College in London, where I was invited some years ago by Prof. Armstrong to found a class in the subject, and where excellent work is now being done by Mr. Pope. That it is found necessary to insist upon this study in a technical college of all places in the world is surely a remarkable confession that this, like every pure science, is far from being devoid of practical application.

If we turn now to mineralogy proper, the practical value of this science is obvious without any explanation.

In mining and metallurgy we have subjects of vast commercial importance in which a knowledge of scientific mineralogy is most desirable.

In particular it would be a great advantage to this country if all who are sent out to hold official positions in new or distant lands, could receive some previous instruction in the study of minerals which are of economic importance. We should not then hear of ruby companies formed through sheer ignorance to exploit what subsequently proved to be red garnets, neither would valuable ore deposits be overlooked for years simply because no one among the early settlers was familiar with the aspect of the common metallic minerals. I have no doubt that a course of lectures upon the detection of gold, silver, and precious stones, would prove attractive even in Oxford in these days of mining adventure and speculation, and I would not deny that they might be of some service to those whose future work lies in India or the colonies, or to those who travel in little-known regions. But I feel very strongly that our business here is with general education, and that the later the date in any educational system to which extreme specialisation or technical training can be postponed the better it will be for the student.

For this reason mining and metallurgy, which belong to technical education, have in my opinion no more place in such a university as this than any other branch of industrial or applied science. We do not seek here in the matter of practical engineering to compete with the great engineering workshops, or in the matter of clinical instruction with the great London hospitals; and in the same way, we should no more expect or desire to compete here with mining or metallurgical schools than to teach the jeweller's art.

A university can best serve the cause of technical education

by teaching precisely those features of any science which can not well be learnt in later life, and yet are the very foundation of practical knowledge; to the engineer his abstract mathematics and physics, to the medical man his physiology and comparative anatomy. Nothing can better illustrate the enormous value to the manufacturer, for example, of a sound training in pure science than the manner in which Germany has taken the lead in certain chemical industries owing to the excellent scientific instruction received at the universities by the men employed in those industries. Or, to take another instance, it has been confessed by the electrical engineers that the marvellous rapidity with which their industry has grown is largely due to the fact that the mathematical theory had been mainly elaborated before electrical science found its application; there can be no doubt that years of blundering were saved by this fact, for the form and structure of the mechanism required could be almost from the first worked out by well-established principles instead of blind trials.

In the same way I believe that the study of scientific mineralogy has a very considerable value, both educational and practical.

For the successful pursuit of this science a student must combine no inconsiderable knowledge of chemistry, physics and crystallography, and must therefore be to some extent familiar with certain branches of mathematics; if he is further to study the interesting problems of the origin, growth and changes of minerals, he must also be acquainted with the kindred science of geology. There is no fear lest a student of mineralogy should too early become a specialist; as a branch of natural history his science encourages habits of minute observation, as an experimental science it involves accurate physical and chemical work. I am speaking, it will be understood, of scientific mineralogy, the study of the nature and properties of minerals in themselves quite independently of their uses and applications; one who is a master of these matters will not be slow to find the applications.

My predecessor in this chair always set before himself this high ideal, and during a period of forty years endeavoured to kindle among those who attended his lectures an interest in the more purely scientific aspects of mineralogy. As one of his pupils who, having conceived some degree of enthusiasm for the subject, was greatly encouraged by his inspiration, I am glad to have this opportunity of acknowledging my gratitude to Prof. Story-Maskelyne for directing the thoughts of his students in the ways of pure science: I believe it to be the proper course to pursue in the higher teaching at a university.

In this connection I should have been glad to devote the present address to the elucidation of a certain feature in mineralogy which has an educational interest; the fact, namely, that the order in which a subject can best be unfolded before a student's mind is very satisfactorily marked out by the historical development of the subject; that a profitable course of teaching is suggested by the history of a science; and that the order in which problems have presented themselves to successive generations is the order in which they may be most naturally presented to the individual.

It is a principle which comes out very forcibly in the case of mineralogy, and it may, for aught I know, be equally characteristic of other sciences.

First would come the examination of stones by all sorts of simple means; the study of the external characters by which they may be recognised; their colour and lustre; their hardness and weightiness; the methods of recognition employed by the miner; the system of study, in fact, which prevailed in the early part of the century, when the genius of Werner drew students from all parts of Europe to the Mining Academy of Freiberg: a system known as the natural history method. This is an exercise admirably adapted to train the faculty of inquisitive and careful observation in the schoolboy, and in my opinion should be unnecessary in the higher teaching of the science, although it does in an incongruous manner survive therein throughout the German and other universities.

Next, by a transition through the simpler chemical tests, the learner is led to the refined chemical analysis of minerals; a study to which far too little attention is paid at the present day, yet one from which the most fruitful results are to be expected.

Finally, as an inquiry suitable for the most advanced students, follows the investigation by exact methods of the internal structure and constitution of minerals; leading to such researches as are now being prosecuted in Oxford with remarkable success by Mr. Tutton.

Nothing can be more suggestive, from the educational point of view, than the curious history of mineralogy. An excellent account of the early phases is given in the "History and the Philosophy of the Inductive Sciences" of Whewell, who was, it will be remembered, Professor of Mineralogy at Cambridge before he became Professor of Moral Philosophy. But to dilate on these matters would be to do what I have already undertaken to avoid, to celebrate the educational virtues of my own science.

In choosing a subject to which I could more particularly devote an inaugural lecture, I have thought that one which is both interesting and suggestive, even from the scientific point of view, is to be found in the beauty of minerals. No one can glance through a collection of minerals, such as that which adorns this museum, without being impressed by their varied beauty of form and of colour; no one can read what has been written on the subject by Ruskin, without feeling that in their æsthetic aspect they possess a singular fascination. We are perhaps more familiar with them when they have been wrought into beautiful objects by the art of man; the beauty of marble and serpentine, of malachite and lapis lazuli, among decorative stones; that of sapphire and emerald and opal, among jewels; or of onyx and agate, among the less precious gem stones, is known to all. Yet their beauty is mainly that of the minerals themselves, and the hand of the artist does little more than make it visible. Few perhaps, save those who have had personal experience among minerals, are aware of their intrinsic beauty: let any visitor to a museum spend one half-hour among the mineral cabinets, and he will find his reward in the purely æsthetic pleasure to be derived from the contemplation of objects unrivalled in beauty of form and colour. The magnificent collection preserved in the British Museum is, of course, that from which the greatest pleasure can be derived; and in that collection there are no more interesting objects than the fine agates and chalcedonies brought together by Mr. Ruskin with the special purpose of illustrating their beauty of colour and structure. But even in a comparatively small collection like that of our university, there is much that will attract and gratify the eye.

Confronted by this wealth of beauty and interest, the reflective mind is led to propose to itself the question, What is the origin, and what is the object of all this beauty? what purpose does it serve in the economy of nature? In the beauty of the organic world it is possible to imagine both an origin and a purpose. The origin may conceivably be sought in utility. Even if it be denied that in the organic kingdom beautiful objects, whether plants, animals, or human beings, have become useful because they are beautiful, it may, at any rate, be suggested that they appear beautiful because they are useful. But in the mineral world it is altogether different; these wonderful spars and gems, with their infinite variety of form and colour, their intricate groupings of silky fibres and pearly flakes, may have been for ages hidden in dark recesses of the earth where they have led an unchanging existence; and when they are brought to the light of day for the use of mankind, we can admire their beauty, but we cannot see any purpose for which, or any process by which it has been acquired. It may be answered that herein is no cause for surprise; that there is no reason why inanimate objects should not be both beautiful and interesting in themselves apart from any teleological aspect; that, indeed, it is gratifying to find a branch of natural science into which utilitarian considerations do not enter. This may be so, but nevertheless the fact indicates a very remarkable distinction between minerals and other natural objects.

Let us pursue to its conclusion the inquiry which we have provoked, and see whither it leads us.

In the first place, I would point out that the distinction relates not only to the beauty, but to all the properties of minerals; we may equally inquire about them: What is their origin and what is their object? What purpose do they serve in the economy of nature? They have not been acquired by selection, they do not impart any advantage to the mineral itself.

The contrast between minerals on the one side, and animals and plants on the other, is very obvious. There is with the former no change or development, neither progress nor degeneration; no survival of the fittest, no variation of characters. They are perfect and complete, each in itself, immutable and immortal. No struggle for existence takes place in the mineral world as it does among the individuals of the animal and vegetable kingdoms.

It may be answered that this is natural, for such individuals do not exist in the mineral kingdom. In other objects which

possess no individuality there is also no progress, and it is absurd to look for any development among ores, and stones, and rocks. That, however, is not so obvious.

Individuals exist in the mineral kingdom just as truly as they exist among animals and plants; each crystal is a distinct individual, capable of growth by itself, and independent of its fellows; each pursues its own existence; it is even in a sense capable of multiplication, for if a crystal growing from solution be broken in two, each half continues to grow as a distinct individual resembling in all respects the parent crystal.

Mutilate a growing crystal by breaking away one of its corners or edges, it will heal the fracture, restore the missing fragment, and become again a perfect crystal; thus asserting its individuality in an even more persistent manner than many a living organism. The experiment is one which may easily be performed with a crystal of alum.

Hence if a definition of life, or a distinction between organic and inorganic be based upon individuality, as it often has been, it will be exceedingly difficult to exclude crystals. This is precisely what many philosophical writers have found. One or two examples will suffice.

Schopenhauer, for instance, after stating that "in the inorganic kingdom of nature all individuality disappears," is obliged to confess that "the crystal alone is to be regarded as to a certain extent individual"; "in the forming of a crystal we see as it were a tendency towards an attempt at life." Having made this admission he goes on to say: "The crystal has only one manifestation of life, crystallisation, which afterwards has its fully adequate and exhaustive expression in the rigid form—the corpse of that momentary life." There is a constant tendency among philosophical writers to suggest that this individuality implies some relationship between life and crystallisation.

To take another illustration: St. George Mivart says that "in crystals and such forms as dolomite and spathic iron we have an adumbration of organic forms." There is a dubiously expressed feeling, even among writers upon evolution, that crystals may to some extent bridge over the great chasm between living and non-living objects.

Most striking and most surprising of the utterances upon this subject which I have encountered, considering its author, is a remark by Huxley in an article upon the origin of species, in which he says:—

"The inorganic world certainly has its metamorphoses and, very probably, a long Entwickelungsgeschichte out of a nebular blastema. Who knows how far that amount of likeness among sets of minerals in virtue of which they are now grouped into families and orders, may not be the expression of the common conditions to which that particular patch of nebulous fog which may have been constituted by their atoms, *and of which they may be in the strictest sense the descendants*, was subjected?"

What we are really led to see when we pursue further the comparison between minerals and organisms is not a resemblance, but an irreconcilable difference.

In the mineral world the forces of nature act upon the individual without producing any modification.

It is true that by chemical processes a crystal of olivine may have some of its constituents taken from it, and others added to it, whereby it becomes a totally different mineral, serpentine. Or by exposure to the air, a crystal of felspar is converted into crystals of a totally different mineral, china-clay; but until it is destroyed, there is no change or progress of the individual. Each remains, like Bishop Blougram, "calm and complete, determinately fixed, to-day, to-morrow and for ever." There is no response to external stimulus, no adaptation to environment.

The properties, the form, the beauty of living beings are due to continual interaction between external forces and the organism itself. In the organic world the teleological aspect, I imagine, can never be lost from sight; each individual works for its own salvation; unceasing change involves either unceasing progress or degradation. With the mineral this is not so. A crystal of natural quartz has doubtless been the same and has possessed the same properties for countless ages.

In an ever-changing world the crystal is a type of unchanging constancy—its properties remain as permanent as those of the very elements themselves.

The crystal and the organism differ herein, that in studying the latter we have to take into account not only the unknown properties of the organism itself, but the nature of its environment and the character of the forces to which it is subjected; whereas in studying the mineral, we find that its properties express only the nature of the crystal in itself, and are therefore the same whatever may be the conditions of its growth and existence.

When we pass from the crystal even to other inanimate objects, this is no longer the case; the beauty, the form, the characters of any other natural objects are the result partly of their inherent properties and partly of the forces which act upon them. They have been, to some extent at least, moulded by their environment. The form of a mountain is due partly to the nature of the rock of which it consists, partly to the action of the wind, the water, and the weather to which it is exposed. The curve of a coast-line and the contour of its cliffs are to be attributed partly to the durability or the weakness of the chalk or the slate of which it is composed, but partly also to the sweep of the prevalent currents, the direction of the winds, and the rise and fall of the tide.

In no character is this more conspicuous than in symmetry of form and character.

The symmetry of living things is obviously due largely to their environment or to their movement. The symmetry of a tree depends upon the fact that the conditions under which a root grows are different from those which prevail where the branches spread; the symmetry of a fish is intimately connected with the fact that it swims in one direction; the bilateral symmetry of a man can be, I presume, referred to a similar cause. There is no inherent symmetry which is absolutely independent of external force. Vary the conditions, and the symmetry of the organism is varied in response. But in the mineral it is otherwise—the symmetry is essential and inherent; it belongs to the mineral quite independently of external forces. In the study of crystals we are in an altogether unique manner brought face to face with the nature of the thing in itself; surely an uniquely interesting subject for study.

But the contrast can be pursued still further.

The symmetry of crystals is expressed not only in their external form, but in all their properties internal as well as external. They have been the object of much attention on the part of careful experimentalists using the most refined methods of modern physics, and the result has been to establish this fact in the most unmistakable manner. Their symmetry is one not only of external form, but of internal structure. Further it is of a peculiar character, which entirely differentiates crystals from all other things animate or inanimate. It absolutely distinguishes the crystalline individual from the organism. No crystal has the symmetry of any organism, no organism has the symmetry of any crystal.

The latter has recently been the subject of much geometrical investigation, which is probably unknown to others than mineralogists, and a very interesting and suggestive discovery has been made by geometers working independently in Germany, France, Russia and England. The physical study of crystals, their action upon heat, light and electricity, has disclosed another remarkable feature characteristic of them. They are without exception homogeneous. At any point within a crystal its properties are absolutely the same as those at any other point within the same individual. This must be due to homogeneity of structure.

Just as a man walking in an orchard of identical trees planted in a regular geometrical manner, the Roman quincunx for example, would not be able to distinguish one part of the orchard from another by reason of its homogeneity, so we must imagine that Clerk Maxwell's demon, able to transport himself from one point to another within a crystal among the crowd of molecules, or particles, or whatever they may be of which it consists, would not be able to distinguish the one spot from the other.

The geometricians have therefore inquired in what manner such a homogeneous structure can be symmetrical.

In other words, if you take an infinite number of identical things, no matter what they be—molecules, portions of matter, systems of forces, or anything else—and range them side by side, either parallel to each other, or facing different ways, or turned inside out; provided only they are so arranged that the distribution at any one part of the mass is the same as at every other part, what will be their symmetry? This is a purely geometrical problem. The solution leads in the most remarkable way to precisely that sort of symmetry which is characteristic of crystals and of nothing else. Hence it follows that the symmetry of crystals results from their homogeneity, and is not an independent feature.

The result of our inquiry has been, therefore, not to suggest

any fanciful resemblance between life and crystallisation, but to disclose a fundamental difference; not to bridge over the chasm between animate and inanimate objects, but to widen the gulf.

Crystals are symmetrical individuals by virtue of their homogeneity. Organisms cannot be homogeneous in the same sense, or they would possess the symmetry of crystals. One is led to conclude that the organic individual is never homogeneous, but consists of parts which are essentially different, just as the head is different from the body, the leaf from the stem, or the shell from the kernel.

This I imagine to be the result to which biologists have been led by quite independent reasoning: every organic individual, even the simplest possible individual, the cell, whether animal or vegetable, consists of parts which are different; a nucleus, for example, and something distinct from the nucleus.

We may even proceed a step further, for more is implied in this homogeneity than mere similarity of parts. It is also necessary that the parts should not change places. A gas may be homogeneous by virtue of the rapid and irregular movements of its particles; it may be the same at every point, because it is throughout devoid of any orderly arrangement. But this is not the sort of homogeneity which leads to crystalline symmetry. In the case of crystals there can be no taking the average of crowds of irregularly moving particles, such as forms the basis of the kinetic theory of gases; there can be no talk of a drifting of Lucretian atoms, although this was actually put forward as a theory of crystal structure some years ago.

Lord Kelvin's Boyle lecture on crystal tactics, which was delivered in this very room three years ago, dealt with these subjects, and it will be remembered that a crystal was in that lecture regarded as constructed of a number of bodies placed side by side in regular order, and all facing the same way. There can be no doubt that the ultimate particles of a crystal are really in motion, but their motions must be so circumscribed that none encroaches upon its neighbour, and the crystal may therefore be regarded as constructed of immovable units. In contrast with this, I imagine that any organism, even any organic cell, consists of parts which are not only different, but possess differential motions: this fact is indicated, I presume, by the life of any organism, and its growth by intussusception.

Our final conclusion is, therefore, that the symmetry of a mineral differs entirely from that of an organism, and is due to its homogenity and the fixity of its parts. We have been led to something resembling, in some degree, the Homœomeria of Anaxagoras.

It is remarkable that the earliest writer concerning minerals, whose works have survived, uses language which might almost be applied to the discoveries of yesterday; Theophrastus, in his treatise on stones, says that the crystal must be regarded as formed by the concretion of matter pure and equal in its constituent parts, ἐκ καθαρᾶς τινὸς συνεστάναι καὶ ὁμαλῆς ὕλης.

Among modern writers, Herbert Spencer has most explicitly stated that there is some such distinction between living and non-living things. He says: "Matter has two solid states, distinguished as colloid and crystalloid, of which the first is stable and the second unstable. Organic matter has the peculiarity that its molecules are aggregated into the colloid and not into the crystalloid arrangement." This almost amounts to saying that matter which lives cannot crystallise, and that crystallisable matter cannot live.

You will now see that the inquiry with which we began has led us far from our starting-point, and that, under the guise of some reflections upon the beauty of minerals, I have really been inflicting upon you a dissertation upon one of the most abstruse problems of mathematical crystallography—that concerning the ultimate structure of crystals.

You will also see that having proposed the question—What is the origin and purpose of mineral beauty?—I have not been so foolish as to attempt an answer, or to explain why minerals are beautiful, but have merely asserted that their beauty, like all their other properties, cannot have been acquired, and that in this they differ from living things.

My object in venturing on this difficult subject was two-fold. In the first place, I was anxious to show that mineralogy, taken even on its most abstract and most highly specialised side, overlaps other sciences, even biology, with which it might be expected to possess absolutely nothing in common. It brings us face to face with problems relating to the nature of life. Those who study the nature of living things cannot afford to ignore the nature of crystals, any more than those who study the nature of crystals can ignore that of living things.

If to the chemist and physicist some knowledge of crystallography is an absolute necessity, to the biologist it is at any rate a matter of interest.

Those who heard Lord Kelvin's Boyle lecture will have realised both the importance and the difficulty of these speculations relating to the ultimate structure of crystals; speculations which have attracted the keenest interest among many acute thinkers.

It is often forgotten that the earliest scientific work of the great Frenchman, whose name is associated with some of the most magnificent biological discoveries of the age, was in this direction. Pasteur was, at the very outset of his career, attracted by the relation between crystallisation and life. He imagined that in a peculiar mode of symmetry which he discovered in certain crystals, he had found an essential difference between living and non-living material, and that only such crystals as present this particular symmetry are the products of life. It has now been proved that such a symmetry is one which results from crystalline homogeneity, and is therefore proper to crystals; but the interesting fact remains that Pasteur entered upon his study of organisms by the way of crystallography, and that the one was inextricably bound up with the other.

Buckle saw in the history of mineralogy the strongest confirmation of his own views upon organic life. He regarded the early discoveries of the great French mineralogist Haüy, concerning the form and structure of crystals, as one of the most important contributions "to the magnificent idea that everything which occurs is regulated by law, and that confusion and disorder are impossible." Referring to the remarkable power possessed by crystals, in common with animals, of repairing their own injuries, he says: "However paradoxical such a notion may be, it is certain that symmetry is to crystals what health is to animals. When therefore the minds of men became familiarised with the great truth that in the mineral kingdom there is, properly speaking, no irregularity, it became more easy for them to grasp the still higher truth that the same principle holds good of the animal kingdom."

And this leads me to the second reason which I had for selecting my subject, namely, the excellent illustration which it affords of the manner in which each branch of human thought not only overlaps every other, but requires its support.

If philosophic writers can illustrate their views by misleading statements, it is because their illustrations are drawn from subjects with which they have little personal acquaintance, and because they have not consulted those who have made a special study of such subjects. It seems to me that here in Oxford, above all places, more might be done in the matter of mutual assistance, and I am thinking not so much of the aid which might be given by science to philosophy, as of the benefits which philosophy might confer upon science.

I have chosen for my text an instance in which philosophic writers have confused two very different things—the individuality of organisms, and the individuality of crystals, owing to their imperfect acquaintance with the latter. It would have been much easier and far more amusing to select instances in which the scientific specialist has fallen into worse confusion owing to his want of philosophic training.

In Oxford, with our magnificent school of Literæ Humaniores, it seems disastrous that the science student should not receive some of the crumbs that fall from her bounteous table—some encouragement to that philosophic habit of thought in which he acquires far too little training. I can only speak as a specialist, but with the knowledge of what my own subject has suffered through this need, and with the suspicion that this is equally the case with others. It is not for me to suggest how such an object could best be attained; but even if questions were asked in the final school of natural science which would encourage attendance at certain lectures on philosophy, I believe that science students would gain much thereby. It would, no doubt, be equally profitable for the philosophic student to gain some insight into the matters and methods of modern science.

I will conclude by quoting what Goethe has said about crystallography. "It is," he says, "not productive; it exists for itself alone, and leads to no results. The mind derives from it within limits a certain pleasure of satisfaction; its details are so manifold that it may be said to be in exhaustible." "For this reason," he adds, "it has powerfully attracted the acutest intellects, and has kept firm hold upon them."

As regards the want of practical application in this science, the words of Goethe are no longer true. Elsewhere he says: "There is a flavour of the monk or the old bachelor about crystallography, and therefore it is self-sufficient. Practical application in life it has none; its rarest objects—the crystallised precious stones—have to be cut and polished before we can adorn our ladies with them." But you will remember that crystallography means now much more than the study of external form; what is done by the lapidary is really much what is done by the scientific investigator—the result in both cases is to reveal the inherent but hidden beauty of the crystal.

It is, however, very true that there is a self-sufficiency about the science, and for a reason which I have already indicated: crystals can be considered as things which exist for themselves, since their nature is independent of their surroundings.

The philosophic contemplation of these beautiful and unchanging objects among the fleeting scenes of a restless world, does bring with it a philosophic content. Nowhere is the evidence of the permanent order that prevails in nature written in more lustrous and indelible characters than in the mineral kingdom.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE University of Utrecht has just celebrated its 260th anniversary by a series of brilliant *fêtes*.

MR. JOHN R. FELLOWS, of New York City, has given 5000 dols. to Notre Dame University to found scholarships.

THE University of Virginia, which suffered serious damage by fire last autumn, is being rebuilt on the plans of its founder, Thomas Jefferson, friends having subscribed a fund of 250,000 dols. for that purpose.

DR. FRANK P. GRAVES, of Brooklyn, has been unanimously elected president of the State University of Wyoming, located at Laramie. President Graves was born in 1869, and is probably the youngest college president in America.

THE *Electrical Review* states that the Baden Chamber has voted £30,000 to the Technical High School at Karlsruhe, to build a new electro-technical institute. The whole cost of the building projected, exclusive of the cost of the land, is estimated to be about £25,000. The building is to be commenced immediately, and it is expected to be ready for occupation in two years.

THE following are among recent announcements:—Dr. Paul Eisler to be professor of anatomy in the University of Halle; Dr. L. Joubin to be professor of zoology in the Faculty of Science at Rennes; Dr. H. Prous to be professor of zoology in the Faculty of Science in Lille; Dr. J. A. Wislicenus to be professor at the School of Forestry at Tarandt; Dr. G. Frege to be professor of mathematics at the University of Jena; Dr. H. Klinger to be professor of pharmaceutical chemistry in the University of Königsberg, and Dr. Scholl to be assistant professor of chemistry at Karlsruhe.

FOR the evening exhibitions in science and technology offered for competition by the Technical Education Board of the London County Council in April last, and the awards of which have recently been published, 285 candidates entered as compared with 256 last year. There is a similar increase in the number of awards, there being eighty-eight as compared with seventy-seven last session. The examiners' report: "The most noticeable feature was that the performance of candidates who selected such practical subjects as building construction, machine construction, plumbing, metal plate work, &c., was greatly superior, as a rule, to that of candidates who selected branches of pure or experimental science such as mathematics, physics, chemistry, &c." The second conspicuous fact brought to light is the complete want of ability on the part of most of the industrial candidates to deal with the simplest applications of arithmetic to their own trades. This is an old complaint of teachers of technical subjects, and the pity is that it seems as just now as ever. The children from elementary schools leave off their tuition with no knowledge of the principles of arithmetic, though some of them are experts in working ordinary "rules" as they learn to call them. The majority of the successful candidates consist of men engaged in engineering, building, carpentering and plumbing trades. It is to be hoped that one result of their work during the coming session will be to introduce them to those general principles of science on a knowledge of which a successful career in their various avocations most certainly depends.

A BRIEF history of the City and Guilds of London Institute has been received. A glance through the pamphlet should be enough to make members of the Corporation and Livery Companies of London proud of the part they have played in the advancement of technical education in this country since 1876, when, at a meeting of representatives of Livery Companies, it was resolved: "That it is desirable that the attention of the Livery Companies be directed to the promotion of education not only in the metropolis but throughout the country, and especially to technical education, with the view of educating young artisans and others in the scientific and artistic branches of their trades." It was this resolution which led to the foundation of the Institute in 1878. A few years later the Central Technical College—than which there is no more efficient institution for teaching the relations of science to industrial processes—was established. Other Colleges connected with the Institute are the Technical College, Finsbury, the South London Technical Art School, and the Leather Trades School. A very important part of the Institute's work consists of the technological examinations. These examinations have become a powerful agency in encouraging the establishment of technical schools and classes throughout the country, in assisting County Councils and other bodies in the organisation of their local schools and classes, and in securing the useful expenditure of the grants placed at their disposal under the Local Taxation Act, 1890. In 1881 the number of students in attendance at these classes was only 2500, but last year it reached 24,920. The Institute also takes part in establishing and assisting experimental classes in manual training, wood-work and metal-work, cookery, laundry-work, and housewifery, for boys and girls in elementary schools. For this provision and organisation of technical education in the metropolis and in the provinces, the total amount subscribed by the Livery Companies during the past eighteen years is, in round figures, £480,000, of which £150,000 has been expended on buildings and equipment, and the remainder on maintenance, scholarships, prizes, and grants-in-aid. The splendid work done by the various branches of the Institute more than justifies this expenditure.

ON Friday last the Prince of Wales was installed as Chancellor of the National University of Wales; and a large and brilliant company assembled at Aberystwith to witness this crowning of the movement for which educational pioneers in Wales have worked so zealously. After the installation, honorary degrees were conferred upon the Princess of Wales, Mr. Gladstone, Lord Herschell, and Lord Spencer. The three colleges comprised in the new University—Aberystwith, Cardiff, and Bangor—have all been founded within the last five-and-twenty years, and sums amounting to nearly £200,000 have been subscribed to support them. The Welsh people have from very early times shown a desire for knowledge, and now they have a truly national University they will doubtless take still greater pride in developing their heritage. The Vice-Chancellor, Principal J. Viriamu Jones, F.R.S., told the history of the foundation of the University to the Welsh National Society of Liverpool in November last, and a copy of his address, which is published at the offices of the *Western Mail*, Cardiff, was received a few days ago. The need for the University definitely emerged from a proposal adopted by the Cymmrodorion Section of the National Eisteddfod in 1887, that teachers in elementary schools should be trained at the University Colleges. The need was again felt when the Welsh Intermediate Education Bill became law in 1889, for a question which had to be considered in connection with the Bill was the nature and constitution of the authority to which the work of inspecting and examining the intermediate schools should be committed. For these reasons, and because educational pioneers in Wales felt that the existence of a national University was essential to the vitality of the colleges, the foundation of such a University was urged nine years ago, and now what was then ideal has become a fact. Some remarks by Principal Jones on the functions of a teaching University such as that of Wales are not without interest to those who cherish the hope that a teaching University of London may eventually be established. He says:—"It is certainly part of the ideal of any university institution that its professors should be leaders in the departments of scholarship or science which they profess, and that, as such, they should help to frame the courses of study leading to graduation.

Colleges incorporated in a teaching university have this opportunity. Originality of thought has fuller encouragement, and new educational methods have freer play than can possibly be the case in a college of which the students have no other avenue to a university degree than examination by a wholly external examining body like the University of London, however excellent be the conduct of its examinations. An atmosphere of intellectual independence is of the essence of true academic life. The true scholar must breathe it as his native air. And this is not the language of mere theory. It has its immediate practical application on the scientific side. The trained student of science, for instance, entering on manufacturing pursuits should do so with free inquiring eye, ready to believe that it may have been reserved for him to make a discovery of immense value to the industry to which he is devoting himself. I believe that this freedom of spirit is far more likely to be developed and fostered in a teaching university than in a college bound to teach on certain rigid lines laid down by an authority in which it has no part." The first object of the founders of the University of Wales is to ensure that all students of the University shall receive good teaching and thorough training before proceeding to graduation. By this means the University will be made a real force for the advancement of learning in the Principality.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, vol. ii. No. 8, May 1896.—"The Arithmetising of Mathematics" is an excellent translation, by Miss Maddison, of Bryn Mawr College, of an address delivered by Prof. Felix Klein, before the public meeting of the Royal Academy of Sciences of Göttingen, on November 2 of last year. In it Prof. Klein explains his position in regard to an important mathematical tendency which he remarks has for its chief exponent Weierstrass, whose eightieth birthday has been lately celebrated. This tendency he calls the *arithmetising* of mathematics. Like all the author's addresses, this one, now rendered easily accessible to English mathematicians, will repay study.—Next follow three carefully drawn-up reviews, viz. by R. A. Roberts, on a second edition of Darboux's classic treatise, "Sur une classe remarquable de Courbes et de surfaces Algébriques et sur la théorie des Imaginaires." It is matter of regret, Mr. Roberts says, that the author has not devoted some more time to a subject which offered him once such a fruitful field for original investigation.—Then Prof. Böcher examines in detail the "Treatise on Bessel Functions, and their Applications to Physics," by Messrs. Gray and Mathews. He well shows that the writers have by their work filled a real gap in mathematical literature.—In his notice of Miss Scott's "Introductory Account of certain Modern Ideas and Methods in Plane Analytical Geometry," Prof. F. N. Cole states it to be a minor excellence of the book that it is written in the English of English speaking and writing people, *i.e.* there are no abbreviations, and such like, which necessitate constant reference to a "list of signs," &c. He looks upon Miss Scott's performance as a compact, scholarly work on the more accessible principles and methods of modern analytical geometry. "It exhibits to a marked degree that genial breadth of treatment and conciseness which are associated only with mature scholarship and extensive and accurate information." His summing-up of warm approval is that he knows of no introductory work which is better adapted, in the particulars he indicates, for the use of those who desire not merely to learn, but also to master geometry.—Prof. H. B. Newson, in a note on "A Remarkable Covariant of a System of Quantics," calls attention to a covariant of a system of n quantics in n homogeneous variables. He states two important geometric properties of this covariant which, *pro tem.*, he calls the Cremonian. (1) The Cremonian of U, V, and W is the locus of the point (x', y', z') whose first polars with respect to U, V, and W have a common point; the locus of these common points is, of course, the Jacobian. (2) The Cremonian of U, V, and W is also the locus of (x, y, z) the point of intersection of the polar lines of (x', y', z'), with respect to U, V, and W, *i.e.* it is the locus of the point of intersection of the polar lines of the points on the Jacobian. The author gives other results of interest, and hints at an extension of the conception of the Cremonian to spaces of higher dimensions.—Much interesting matter is given in the Notes, and a list of recent publications fills up a big number of 44 pages, in place of the usual 32 pages.

Symons's Monthly Meteorological Magazine, June.—The worst gale of the nineteenth century in the English Midlands (continued). A map is given showing the path of the storm from South Wales to Lincolnshire between 11 a.m. and 4 p.m. on Sunday, March 24, 1895. The average velocity of translation was about sixty miles an hour, and the disturbance appears to have been caused by a subsidiary depression formed over the south of Ireland, during a well-marked cyclone which lay over the northern parts of our islands on the same day. Great disaster was caused along its track, and fourteen deaths were reported. There were also more than a dozen cases of windows and gables being blown *out*, owing to the expansion of air inside the buildings during the passage of diminished atmospheric pressure.—Fog, mist and haze, by a Fellow of the Royal Meteorological Society. This is a continuation of the discussion raised in the preceding number of the *Magazine* (NATURE, June 4, p. 118). The writer agrees generally with the definitions proposed, as a practical scheme, based on a correct view of the phenomena, but he thinks that the difference between fog and mist should not rest upon what can be seen with the naked eye—a test in which two persons would be very apt to disagree.

THE enlarged issue of the *Journal of Botany* still continues to be occupied almost entirely with papers on descriptive botany, and chiefly relating to the flora of the British Isles. In the numbers for May and June, Prof. R. Chodat describes some new species of *Polygala* from South Africa; and Mr. W. H. Pearson a new liverwort, *Plagiochila Stableri*, from Rydal.

THE papers in the *Nuovo Giornale Botanico Italiano* for April, and in the *Bulletino della Società Botanica Italiana*, Nos. 2–4, relate almost entirely to the flora of Italy. In the former, Signor S. Sommier describes and figures an interesting hybrid between *Ophrys bombyliflora* and *O. tenthredinifolia*. In the latter is an abstract of an article by Signor B. Longo, on the mucilage of the Cactaceæ.

Bulletin de la Société des Naturalistes de Moscou, 1895, No. 3.—On considerable perturbations of atmospheric pressure in the year 1887, by B. Sresnewskij. A research into the relations between the said perturbations, the movements of cyclones, and the local weather predictions based on the study of the same; as also their relations, both to the groups of areas of minimal pressure and to the distribution of temperature (in German).—Materials for the Amphibia and Reptile fauna of the Orenburg region, by N. Zarudnyi. List of eleven species of the former, and fifteen species of the latter (Russian).—*Aquila Glitchii*, Severtsoff, a biological sketch, by P. Suschkin, in German, with two plates.—Note on *Posidonomya buchi* of the Balaclava schists in Crimea, by M. D. Stremoouchow, with a plate.—On Russian Zoocecidiæ and their makers, by. Ew. H. Rübsaamen, based on a collection made by Madame Olga Fedchenko and her son Boris Fedchenko. No less than 120 galls and their occupants from various parts of Russia and Caucasia are described.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 11.—"On the Relations between the Viscosity (Internal Friction) of Liquids and their Chemical Nature. Part II." By Dr. T. E. Thorpe, F.R.S., and J. W. Rodger.

In the Bakerian Lecture for 1894 the authors gave an account of their work on the viscosity of some seventy liquids, and they discussed the interdependence of viscosity and chemical composition. In order to render their investigation more complete, they have now made measurements of the viscosity of (1) a number of esters or ethereal salts, and (2) of ethers, simple and compound—groups of liquids, which with the exception of a single member, ethyl ether, have not hitherto been studied by them. The physicochemical relationships previously established made such determinations of special interest, for it was shown that one of the most striking of the various connections traced between chemical constitution and viscosity was the influence exerted by oxygen according to the different modes in which it was assumed to be associated with other atoms in the molecule. The influence which could be ascribed to hydroxyl-oxygen differs to a most marked extent from that of carbonyl-oxygen, and it appeared that ether-oxygen, or oxygen linked to two carbon atoms, had also a value which differed considerably from oxygen in other conditions.

The details of the observations are given in precisely the same manner as in the first paper, and formulæ of the Slotte type showing the relation between viscosity in absolute measure and temperature are calculated for each liquid. The general results of the observations are then discussed in the same manner as in the previous memoir.

The conclusions relating to the graphical representation of the results may be thus summarised. Both ethers and esters give no evidence of molecular aggregation, and conform to the rules that :—

(1) In homologous series, the viscosity is greater the greater the molecular weight.

(2) An iso-compound has a smaller viscosity than a normal isomer.

(3) The more symmetrical the molecule of an isomeric compound the lower is the viscosity.

As regards the esters themselves, it is noteworthy, where the comparison is possible, that :—

(4) Of isomeric esters, the formate has the larger viscosity.

As regards the algebraical representation of the results, it is shown that in the expression $\eta = C/(1 + \beta t + \gamma t^2)$, derived from Slotte's formula :—

(1) In any homologous series, β and γ increase as the molecular weight increases.

(2) Of isomeric compounds, the iso-compound has the smallest coefficient.

(3) Ethyl ether, the symmetrical isomer, has smaller coefficients than methyl propyl ether.

(4) As regards normal isomeric esters, the formate has the largest, and the propionate the smallest coefficients, and the values of the acetate are larger than of the butyrate.

The authors then deal with the relationships existing between the various viscosity magnitudes—the viscosity coefficient, the molecular viscosity, and the molecular viscosity work—(1) at the boiling point, and (2) at temperatures of equal slope, the slope adopted being that employed in their previous paper, namely, 0·04323, and values for the oxygen in three different conditions are given for each system of comparison in the same manner as in their first communication.

Physical Society, June 26.—Captain Abney, President, in the chair.—Mr. F. Bedell read a paper on admittance and impedence. The author discusses the application of the method of "vector diagrams" to the solution of questions connected with alternating currents. He shows how, by a consideration of the loci of the different lines on such a diagram, many problems which require for an analytical solution a lengthy investigation, may be simply and expeditiously solved. Mr. Blakesley asked the author what was his test of resonance? Was it that the primary current and E.M.F. were exactly in the same or in opposite phase? The term resonance was an acoustical one, and he did not see why it should be applied to one particular case in the electrical problem. Mr. Inwards asked what degree of accuracy the author had obtained. The author in reply said that if the applied E.M.F. and the current were brought into phase by means of a condenser in the secondary, then he called that a case of resonance. The agreement between the experimental and theoretical results was generally within from 1 to 3 per cent.—Prof. S. P. Thompson read a paper on the properties of a body having a negative resistance. The author, after showing the consequences which would follow according to the laws of Joule and Ohm if we postulate the existence of a body having a negative resistance, goes on to show how the observations described by Messrs. Frith and Rodgers, in a paper read at a recent meeting of the Society, only prove that that part of the resistance of an arc, which is not constant, is a positive resistance that varies inversely as the current. Since it varies inversely as the current the term dR/dC will be negative, and so will the quantity $C(dC)/dR$, which is what they have tabulated as a negative resistance. That the resistance of the arc itself should vary inversely as the current is natural, for it may be regarded as a column of vapour, the cross-section of which is proportional to the current, and therefore increasing in its conductance in direct proportion to the current. There is no need even to suppose any (distributive) adjuvant E.M.F., which would be the other alternative to the suggestion they have made Mr. Swinburne asked if the numbers on which Messrs. Frith and Rodgers based their arguments were obtained by taking successive readings of a voltmeter. Prof. Ayrton said that what they maintained was, that if the arc acts as if it had a back E.M.F. and a resistance, then the resistance is a negative quantity. In ordinary cases we do not know what really constitutes a resistance, but simply say that a circuit, in which electrical energy is being dissipated at a rate proportional to the square of the current, has resistance. If the loss is proportional to the first power of the current, then we say there exists a back E.M.F. Is it impossible to imagine a circuit in which a loss of electrical energy occurs proportional to the current, and a return of energy to the circuit proportional to C^2? If in a curve showing the relation between V and C you draw a tangent at any point, it is not the tangent of the inclination of this tangent which Messrs. Frith and Rodgers have called the resistance; it is another quantity, which they call the electrical dV/dC. In conclusion the author seems to have based his paper on three misconceptions: (1) That it had been claimed that a negative resistance could exist alone. (2) That the curves given by Messrs. Frith and Rodgers showed that the ordinates were inversely proportional to the current. (3) That what was measured was the geometrical dV/dC. Mr. Frith said that in a paper by Mr. Rodgers and himself, they had defined the resistance of the arc as the ratio dV/dA, where by dV/dA they meant, not what was ordinarily understood by this expression, but the value of the ratio obtained by superposing an alternating current for a direct current arc. In order to show that, in cases analogous with that of the arc, but in which the true resistance can be verified, the electrical dV/dC obtained by superimposing an alternating current gives correct results for the resistance, some experiments have been carried out. In one case a glow-lamp was placed in series with some fifty ampere secondary cells, and a current sent through against the E.M.F. of the cells. The value obtained for the electrical dV/dC agrees very well with the value of the resistance obtained by dividing the P.D. between the terminals of the lamp by the current. At very low frequencies for the superimposed alternating current it is evident that the electrical oscillations would travel along the steady value curve, and this is clearly the meaning of the critical frequency observed with cored carbons, namely, that under the critical frequency the superimposed alternating current travels on the steady value curve, and over that frequency along the line joining the point on the curve and the instantaneous origin.—Mr. Frith exhibited a mechanical model of the arc which he has devised. This model consists of two rods of carbon dipping in two mercury cups which are traversed by the current. The current also passes through a solenoid which attracts an iron core attached to the carbon rods and draws them down into the mercury, thus reducing the resistance of the instrument. Hence it can be arranged so that the P.D. between the terminals decreases as the current increases. With this model it is found that, for superimposed oscillatory currents of such a frequency that the moving parts are not able to follow the changes in the current, the oscillations of the current and of P.D. are in phase, and the electrical dV/dC gives the resistance of the apparatus for various currents. Mr. Carter asked the author how on his vapour column theory he explained the difference in the behaviour of solid and cored carbons. Mr. Enright asked why it was absurd to suppose that a negative resistance could exist. Prof. Ayrton and Mr. Frith had made in their definitions certain restrictions; it ought, however, not to be necessary to make any such restrictions. Mr. Blakesley asked if, since the title of the paper by Messrs. Frith and Rodgers was entitled the "*true* resistance of the arc," it was to be inferred, as the results given were negative, that a negative ohmic resistance existed in the arc. Prof. Thompson's paper appeared to him (Mr. Blakesley) to be rather a mathematical than a physical paper. Prof. Rücker said that the discussion showed that considerable confusion existed, and that the introduction of the term negative resistance only tended to fog matters. It was entirely wrong to argue that because you have a quantity with a positive value, therefore a negative value must also be possible. As an example, take the case of mass. If you defined as a positive mass that which is attracted to the earth, and then found that cork when immersed in water was repelled from the earth, would you therefore say that cork had a negative mass? Is not "negative resistance" a term for which some equivalent could be found which would not lead to confusion? Mr. Hovendon made some remarks on his experiments. The author in his reply said that he did not dispute the accuracy of the results obtained by Messrs. Frith and Rodgers, but it was the interpretation which they had given of their results to which he objected. Mr. Frith now makes a new reservation, namely, that the results depend on the particular

way in which the increment of C and the decrement of V are made. He supposes that if the experiment is made in a particular way a new slope is obtained which is proportional to what we call the true resistance, and hence gets a new definition of the quantity dV/dC. He (the speaker) endorsed all Prof. Ayrton had said as to the interest of the model exhibited. The question is, Is there anything in the arc which acts as a source of energy to the circuit, either as a negative resistance or as an adjuvant E.M.F.? Mr. Frith's experiments do not give us any hint as to the point where the negative resistance occurs, and the absence of any such energy-giving portion of the arc is rendered probable by the fact that the arc itself is hotter than the crater. In reply to Mr. Carter, the anomalies which occur with cored carbons are so great as to prevent any argument being based on their behaviour. The Chairman (Captain Abney) said that the mere fact that the quantity dV/dC had been defined in two distinct ways, showed that the definitions would have to be modified in some way.

Zoological Society, June 16.—Sir William H. Flower, K.C.B., F.R.S., President, in the chair.—Mr. E. E. Austen gave an account of a journey undertaken by Mr. F. O. Pickard-Cambridge and the author up the Lower Amazons, on board Messrs. Siemens Bros. cable s.s. *Faraday*, for the purpose of making zoological collections on behalf of the British Museum. No terrestrial mammals were met with, but observations were made on the two species of freshwater dolphins (*Inia geoffroyensis* and *Sotalia tucuxi*, or *S. fluviatilis*), which are extremely abundant in the Lower Amazons. Among the birds, the only species of special interest collected were a little goatsucker from Manaos, referred provisionally to *Nyctiprogne leucopygia*, and a woodpecker (*Celeus ochraceus*), of which the British Museum previously possessed but two specimens. The reptiles and amphibians met with all belonged to well-known and widely distributed forms, and the chief interest of the collections centred in the invertebrates. Among these Mr. Pickard-Cambridge made a large collection of spiders, including an extensive series of the large hairy Therephosidæ, eleven species of which were pronounced to be new. An interesting collection of the nests of some of these forms was also obtained. Mr. Cambridge likewise secured several specimens of *Peripatus*. Mr. Austen, who devoted himself chiefly to insects, obtained some 2500 specimens of different orders, of which it was expected that a fair proportion would prove to be new. Attention was drawn to some interesting examples of mimicry.—Mr. P. Chalmers Mitchell read a "Contribution to the Anatomy of the Hoatzin (*Opisthocomus cristatus*)." He stated that from the characters of the alimentary canal, the hoatzin might be placed either between the sand-grouse and the pigeons, or between the Gallinæ and the Cuculidæ. He described some interesting individual variations in the condition of the ambiens muscle, and referred to other points in the muscular anatomy.—Mr. G. A. Boulenger, F.R.S., gave an account of the occurrence of *Tomistoma schlegeli* in the Malay Peninsula, and added some remarks on the atlas and axis of the Crocodilians.—A communication was read from Mr. W. Schaus containing notes on Walker's American types of Lepidoptera in the University Museum, Oxford.—Mr. Hamilton H. Druce read a paper entitled "Further Contributions to our knowledge of the Bornean Lycænidæ," in which he referred to about forty species of this family not hitherto recorded from Borneo. A number of these were new, and were now described by Mr. G. T. Bethune Baker and the author.—Mr. F. G. Parsons read a paper on the anatomy of *Petrogale xanthopus* as compared with that of other kangaroos. Dr. J. Anderson, F.R.S., communicated on behalf of Miss M. E. Durham some notes on the mode of swallowing eggs adopted by a South African snake, *Dasypeltis scabra*, as observed in the specimens now living in the Society's Gardens, and illustrated by a series of drawings.—Mr. F. O. Pickard-Cambridge read a paper on the spiders of the family Aviculariidæ taken during the expedition up the Amazons previously described by Mr. Austen.—Mr. G. A. Boulenger, F.R.S., read the description of a gecko which he proposed to refer to a new genus and species as *Mimetozoon floweri*, in honour of Mr. Stanley Flower, who had obtained the specimen at Penang.

Royal Meteorological Society, June 17.—Mr. E. Mawley, President, in the chair.—Mr. H. Harries read a paper on Arctic hail- and thunder-storms, in which he showed that the commonly accepted opinion that hail- and thunder-storms are almost, if not quite, unknown in the Arctic regions is incorrect. He had examined 100 logs of vessels which had visited the Arctic regions, and found that out of that number no fewer than 73 showed that hail was experienced at some time or other. Thunder-storms were not so frequent as hail, but they have been observed in seven months out of the twelve, the month of greatest frequency being August. Mr. Harries is of opinion that the breeding-place of thunder-storms in these high latitudes is in the neighbourhood of Barent's Sea.—A paper, by Mr. J. E. Cullum, on the climatology of Valencia Island, was also read. The observatory at Valencia, which is under the control of the Meteorological Office, is situated on the extreme south-west coast of Ireland, and is almost the most westerly point of Europe. Continuous records from self-recording instruments were carried on from 1869 until 1891, when the observatory was removed to Cahirciveen, and the author gives the results of the observations for these twenty three years.

Royal Microscopical Society, May 20.—Mr. A. D. Michael, President, in the chair.—Mr. E. M. Nelson exhibited and described a small portable microscope, which had been designed by Dr. Ross for the investigation of cases of malarial fever. The President said that the instrument seemed to be very compact, and in this respect would no doubt be found of great value. Mr. J. E. Ingpen wished something could be done in designing microscopes of this kind to get them to fold up a little flatter.—Mr. J. Rheinberg's paper, on an addition to the methods of microscopical research by a new way of optically producing colour contrast between an object and its background, or between definite parts of the object itself, was read by Mr. Nelson.

June 17.—The Rev. Canon Carr, Vice-President, in the chair.—Surgeon V. Gunson Thorpe, R.N., exhibited and described some Rotifera, preserved after Rousselet's method, which he had collected whilst on the China station.—Lieut.-Colonel Siddons, R.A., exhibited and described a portable microscope which he considered met the suggestion offered by Mr. Ingpen at the previous meeting.—Mr. Conrad Beck read the report of the sub-Committee of the Council on screw-tools.

PARIS.

Academy of Sciences, June 22.—M. A. Cornu in the chair. An expression for the skin friction in the irregular flow of a fluid, by M. J. Boussinesq.—Some properties of the primitive roots of prime numbers, by M. de Jonquières.—On the caustic of an arc of a curve reflecting rays emitted by a luminous point, by M. A. Cornu.—On the formation of gaseous and liquid hydrocarbons by the action of water upon metallic carbides. Classification of the carbides, by M. H. Moissan. A *résumé* of the work done by M. Moissan and his pupils upon metallic carbides, together with some remarks on the geological bearing of the results.—Remarks on a work entitled "Microbial and animal toxins," by M. A. Gautier.—Observations on Swift's comet (April 13, 1896) made with the large equatorial at the Observatory of Bordeaux, by MM. G. Rayet, L. Picart and F. Courty.—Dr. Gill was elected a Corresponding Member in the Section of Astronomy in the place of the late Prof. Cayley.—On the zero of Riemann's function $\zeta(s)$, by M. Hadamard.—On the X-rays, by M. C. Maltézos. Some theoretical considerations as to the possible nature of the rays.—An electrolytic method of desilverising argentiferous lead, by M. D. Tommasi.—Magnetic anomaly observed in Russia, from a letter by M. Moureaux to M. Mascart. In the village of Kotchetovka (lat. 51°, long. 6° 8′ east of Poulkowa) determinations of the magnetic elements at fifteen points within an area of one square kilometre gave values for declination varying between +58° and −43°; for inclination, from 79° to 48°, and for the horizontal component, 0·166 to 0·589. The latter figure, which is the highest value of the horizontal component hitherto observed, was carefully controlled by six measurements at neighbouring points, from the results of which figures between 0·48 to 0·58 were obtained.—On the dark blue nitrosodisulphonic acid, by M. Paul Sabatier. By the action of cuprous oxide upon strong sulphuric acid containing a little nitrite, a deep blue colour is produced, the absorption spectrum of which is closely analogous to that produced by Fremy's potassium oxysulphazotinate (nitrosodisulphonate). The same coloration can be produced by passing a current of nitric oxide mixed with air into sulphuric acid saturated at 60° with sulphurous anhydride.—On the preparation of aluminium alloys by a chemical reaction, by M. C. Combes. A mixture of aluminium with a sulphide or chloride is heated till the reaction

commences. The heat evolved during the chemical action is sufficient to melt the alloy formed provided that there is a sufficient difference between the heat of formation of the metallic sulphide employed and that of aluminium sulphide. Alloys of aluminium with nickel, manganese, and chromium were prepared by this method.—On the action of phosphorus on some metallic chlorides, by M. A. Granger.—Measurement of heat of etherification by the action of the acid chloride upon the sodium alkylate, by M. J. Cavalier. A thermochemical study of the reaction between phosphoryl chloride and sodium ethylate.—On the heat of combustion of acetal and monochloracetal, by M. Paul Rivals.—On the thermochemistry of the chloracetic ethers, by M. Paul Rivals. Action of hydrazine upon the glyoxylic acids of the aromatic series, by M. L. Bouveault. The hydrazones obtained lose CO_2 at 180°-200°, giving nearly quantitative yields of the hydrazones derived from the corresponding aldehydes.

$$R(CO_2H).C=N-N=CR(CO_2H)=2CO_2+R.CH{:}N-N{:}CH.R$$

The yield of aldehyde, however, obtained by the hydrolysis of these hydrazones is not good.—On the constitution of inactive campholenic acid, by MM. Guerbet and A. Béhal.—On the nutritive value of flour and on the economic consequences of excessive sifting, by M. Balland.—On the chemical mechanism of the reduction of nitrates in plants, by M. A. Bach.—On the rational denaturation of alcohol, by M. G. Jacquemin. The addition of crude mercaptan to rectified spirit is suggested as a means of rendering alcohol unfit to drink, without interfering with its industrial applications.—On the deep borings at Charmoy (Creusot) and Macholles (Limagne), by M. A. M. Lévy. The first of these borings showed a rise of 1° C. for every 26 metres, the second (Charmoy) giving a rise of 1° C. for every 14·16 metres.—On the region of Diego Suarez (Madagascar), by M. R. Bourgeois.—On the relations which exist between the first segmentation groove and the embryonic axis in Amphibia and Teleostia, by M. E. Bataillon.—Tuberculosis experimentally shown to be attenuated by the Röntgen radiation, by MM. L. Lortet and Genoud.

PHILADELPHIA.

Academy of Natural Sciences, May 19.—The collections made by Dr. A. Donaldson Smith in Western Somaliland and the Galla country, North-eastern Africa, in 1894, were presented to the Academy. Dr. Smith spoke of the physical features of the regions from which the specimens had been collected, and gave briefly some facts regarding the habits of the animals observed by him. The several sections of the collection were commented on by the specialists of the Academy. The mammals are of unusual interest because these alone have not been studied by authorities elsewhere. They embrace fifty genera and about seventy species represented by over two hundred specimens. Seven genera and twelve species are new to American museums. The collection, except the bats, which are being studied by Dr. Harrison Allen, is in the hands of Mr. Samuel N. Rhoads, who will furnish a detailed report on the material submitted to him. The birds have been studied by Mr. Bowdler Sharpe. One hundred and fifty specimens of about one hundred species have been given to the Acadamy. The insects embrace 871 specimens. The Hymenoptera are being studied by Mr. Wm. J. Fox, who has determined eight species heretofore undescribed.—Mr. Henry A. Pilsbry made a communication on the fish-house deposits of New Jersey.—A paper entitled "The Plantstonokrit, a centrifugal apparatus for the volumetric estimation of the food supply of oysters and other aquatic animals," by Dr Chas. S. Dolby, was presented for publication.

May 26.—A paper entitled "Catalogue of the species of Cerion, with descriptions of new forms," by Henry A. Pilsbry and E. G. Vanatta, was presented for publication.—Mr. Edw. Goldsmith reported that a specimen of supposed Guperite from Hawaii had proved on examination to be an amorphous, soluble sulphate of lime. It is deposited in association with sulphur on the margin of the Kilauea crater, and is either ejected from the volcano or formed by the action of the oxygenated sulphur water on associated minerals.—Prof. Edw. D. Cope described a new genus and species of whalebone whale from the Miocene of the Yorktown epoch, under the name *Cephalotropis coronatus*. It was characterised by an elongation of the parietal and frontal bones, and establishes the relation of the group to the Zenglodonts.—Dr. M. F. Ball described a human exancephalic monster born about the seventh month, in which the brain, although extruded, was well developed.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Fourteenth Annual Report of the Fishery Board for Scotland, 1895, Part 1 (Edinburgh, Neill).—19th Annual Report of the Connecticut Agricultural Experiment Station, 1895 (New Haven).—Rheumatism, its Nature, its Pathology, and its successful Treatment: Dr. T. J. Maclagan (Black).—La Vie d'un Homme. Carl Vogt; W. Vogt (Paris, Schleicher).—Nitro-Explosives: P. G. Sanford (Lockwood).—Wayside and Woodland Blossoms: E. Step, 2nd series (Warne).—Geographical Journal, Vol. 7 (Stanford).—Plants of Manitoba (M. Ward).—Coloured Vade-Mecum to the Alpine Flora for the use of Tourists in Switzerland: L. and C. Schröter, 5th edition (Zürich, Raustein).—Sport in the Alps: W. A. Baillie-Grohman (Black).—Micro-Organisms and Disease: Dr. E. Klein, new edition (Macmillan).—Macmillan's Geography Readers, Book v. (Macmillan).—A Concise Handbook of British Birds: H. K. Swann (Wheldon). Der Lichtsinn augenloser Tiere: Dr. W. A. Nagel (Jena, Fischer).—La Spectrométrie: Prof. J. Lefèvre (Paris, Gauthier-Villars).—Le Nickel: H. Moissan and L. Ouvrard (Paris, Gauthier-Villars).—University Tutorial Series. Matriculation Directory (32, Red Lion Square).—Ros Rosarum, 2nd edition (E. Stock).—The Scenery of Switzerland: Sir J. Lubbock (Macmillan).

PAMPHLETS.—U.S. Department of Agriculture:—Some Mexican and Japanese Injurious Insects liable to be introduced into the United States (Washington).—On the Interpretation of Greek Music: C. Torr (Frowde).

SERIALS.—English Illustrated Magazine, July (Strand).—Revue Générale Internationale, No. 1 (Paris, Ollendorff).—Longman's Magazine, July (Longmans).—Good Words, July (Isbister).—Sunday Magazine, July (Isbister).—Lloyd's Natural History. Butterflies: W. F. Kirby, Part 1 (Lloyd).—Chambers's Journal, July (Chambers).—Natural Science, July (Page).—Journal of the Chemical Society, June (Gurney).—J. C. Poggendorff's Biographisch-Literarisches Handwörterbuch, 3 Band, Liefg. 1 (Leipzig, Barth).—Ergebnisse der Meteorologischen Beobachtungen in Jahre 1895, Jahrg. vi. (Bremen).—Memoirs of the Geological Survey of India, vol. xxvii. Part 1 (Calcutta).—Ditto, Palæontologia Indica, Ser. xiii. Vol. 2: Ser. xv. Vol. 2, Part 2 (Calcutta).—Bulletins de la Société d'Anthropologie de Paris, tome septième, (iv^e. série), 1896, fasc. 1er (Paris).—Mémoires de la Société d'Anthropologie de Paris, tome 2, (3^e sér.) 1er fasc. (Paris).—National Review July (Arnold).—Century Magazine, July (Macmillan).—Notes from the Leyden Museum, October 1895 (Leyden, Brill).—Contemporary Review, July (Isbister).—Morphologisches Jahrbuch, 24 Band, 1 Heft (Leipzig, Engelmann).—Reliquary and Illustrated Archæologist, July (Bemrose).

CONTENTS.

THURSDAY, JULY 9, 1896.

PROFESSOR ROUX'S COLLECTED WORKS.

Gesammelte Abhandlungen über Entwicklungsmechanik der Organismen. Von Wilhelm Roux. Vol. i. Pp. xiv + 816. Vol. ii. Pp. iv + 1075, 10 plates and 33 woodcuts. (Leipzig: W. Engelmann, 1895.)

ALTHOUGH Prof. Roux must be regarded as the founder of that branch of zoological research called "The Mechanics of Development," which has recently become so popular, yet his works are comparatively little known to zoologists in this country; and it will probably occasion a mild shock of surprise to the English reader, to see the two huge tomes which bear Prof. Roux's name.

When, however, one peruses these works, it soon becomes clear, from the numerous complaints on the subject which Prof. Roux makes, that the writer's own countrymen have not been in the habit of reading his publications with that care which their imposing size would seem to demand; and whatever wonder one may feel at this in the first instance, is soon removed when one becomes acquainted with the contents of the volumes. It may be said, we think with truth, that next to the recording of careless observations, the most deadly sin which a zoological writer can commit is prolixity, and it must be confessed that in this respect Prof. Roux sins very badly. The quantity of literature which is pouring in on us is stupendous; it is becoming more and more difficult for a zoologist to keep himself abreast of the times in more than an exceedingly limited department of the subject, and it seems to us that it is the first duty of every writer to put his results as briefly as is consistent with clearness. In justice to Prof. Roux, it should be mentioned that there is in this, as in every "complete edition of works," a good deal of unavoidable repetition, since of course the volumes are made up of separate papers, in several of which the same or similar subjects are treated; but when every allowance has been made, one is obliged to confess that the proportion of theory to fact is enormous, and that no effort is made to put matters in a compact and terse manner.

The first volume may be said to contain Prof. Roux's theory of organic evolution, as well as several applications of it in specific cases. The proper place to commence the perusal is with the second paper; the first paper contains an account of the laws of branching of blood-vessels, which laws are regarded by Prof. Roux as special instances of the general principles deduced in the second essay from a general survey of biological facts.

Prof. Roux first shows the extreme difficulty of accounting by simple natural selection for the innumerable adaptations, carried out into the finest detail, which are met with in all the organs of the vertebrate body. According to this theory, a variation, in order to be preserved, must be of such decided advantage or disadvantage to its possessor as to settle the question of survival. When we find, however, that all over the body secondary blood-vessels are given off at such angles that the blood-current encounters no frictional resistance, that in bones the meshes of the spongy ossification are disposed so as to strengthen the structure only in those directions in which it is apt to be bent, and thus effect the maximum of economy consistent with efficiency; that the fibres of fasciæ are arranged parallel to the directions of tension; how are we to picture to ourselves such arrangements arising from the accumulation of irregular variations? Are we seriously asked to believe that a slight alteration in the direction of the fibres of one of the tendons, or in the angle which a small artery makes with the larger one from which it springs, would determine the survival of an individual? Is it credible that animals are so tremendously hard-pressed for food that such a trifling economy in material would appreciably affect them? Even if we are capable of such confiding faith in the theory, we are met by further difficulties. Suppose, for example, that a better arrangement of the skeletal material in a given bone will save the life of an animal, what right have we to assume that this variation will be accompanied by similar advantageous changes in other organs? Are not the chances a thousand to one, that the advantage which one animal possesses in one organ will be balanced by the advantages which another possesses in another respect, so that natural selection will have no opportunity to heap up variations? It is to be observed that even if we assume that "related parts" vary together, it will help us. For the question s not one of a general change in the character of bones, for instance, all over the body, but of the special adaptation of each bone to the local needs. Further, if we say that at one period in the existence of vertebrates, one organ was of relatively great importance and improved by natural selection, and then another, how are we to suppose that the change from an aquatic to an air-breathing existence took place? Here, as Prof. Roux points out, we must have had simultaneous modifications in almost all the organs of the body: the respiratory and circulatory organs, the limb muscles, the eye and other sense organs, must all have changed at the same time.

It must be admitted that Prof. Roux has brought together a most powerful case against the doctrine of the "all-sufficiency of natural selection," and we feel sure that his arguments will awaken a sympathetic chord in the minds of many, if not most, zoologists, amongst whom there is a general feeling that we want something more than natural selection.

Destructive criticism is, however, always easier than constructive hypothesis, and it seems to us that the hypothesis which Prof. Roux puts forward as supplementary to the ordinary doctrine of natural selection is not by any means satisfactory. Briefly it is as follows. Every cell, he assumes, is made up of various parts capable of assimilation and reproduction (the biophores of Weismann), and it is infinitely probable that the rates of assimilation and reproduction of these parts will not be alike. Hence those which thrive best under the stimuli which are pouring in upon the cell, will increase faster than the others, and gradually squeeze them out of existence, and by this means the most useful cell qualities will gradually be evolved. The same reasoning applies to the cells themselves. We know that in many

organs the old cells are gradually worn out and replaced by new ones. The cells of the formative layer (such as the Malpighian layer of the epidermis) will not be precisely equal in their qualities, and those whose assimilation and reproduction is furthered by the "functional stimuli" (that is, the stimuli, such as light, contact, chemical action, which call forth the performance of the function of the organ as a response) will flourish at the expense of others. The same argument is only capable of a limited application to the case of organs, since different organs fulfil different functions, and one function cannot preponderate at the expense of another without upsetting that balance which is essential to the continuance of life. Nevertheless, that there is some such tendency is shown by the fact that if an organ ceases to perform its function properly (such as occurs, for instance, in the case of the kidney in Bright's disease), it is apt to be pressed upon, and eventually destroyed by, the hypertrophied connective tissue.

It will thus be seen that Prof. Roux's theory, which he calls "the Conflict of the Parts within the organism," is a new explanation of the well-known effects of use and disuse. He points out that it completely differs from the crude mechanical hypothesis put forward by Herbert Spencer in his "Principles of Biology"; this latter, distinguished by Roux as the theory of "Functional Congestion," attributed increase in bulk, due to use, to the increased blood-supply mechanically brought about by increased function. Apart from the fact that increase in bulk in an organ only takes place in those dimensions in which it is called for by its function (thus the epidermis increases in thickness, a muscle in breadth, &c.), whereas increased blood-supply should cause uniform increase in all dimensions, Herbert Spencer's theory is inconsistent with the fact that if the nerves which convey the ordinary stimuli to an organ (such as a salivary gland) are cut, we may have congestion accompanied by degeneration, rather than increase in size.

It must be confessed that there is much about Prof. Roux's theory which induces one to wish that it were true. Apart, however, from the minor circumstance that the assumption of competing parts within the cell is an absolutely unsupported hypothesis, this theory utterly breaks down when we come to consider the question of heredity. Let it be granted that the liver consists of several kinds of cell, some of which perform their function better than others, and thus survive—how are these survivors to impress their peculiarities on that portion of the ovum which is destined to produce the liver in the young animal? It seems to us that before the question of "direct functional adaptation" can be even entertained by zoologists the question of the possibility of the inheritance of acquired variations must be grappled with, and decided one way or the other.

Prof. Roux next passes on to some general considerations on the nature of life and the origin of life and consciousness; he points out that life is not capable of being statically defined; it is, he says, essentially a process, not a series of chemical attributes, and hence it is absurd to suppose that a slight chemical difference is all we have to assume, in order to account for the difference in properties of living and dead protoplasm. The speculations as to the origin of life and consciousness are as fatuous as such theorising usually is, and we think that a little study of elementary psychology would have prevented Prof. Roux giving vent to his extraordinary ideas as to the origin of consciousness.

The remaining papers in the first volume deal chiefly with special cases in which Prof. Roux has elucidated the wonderful functional adaptation which is seen not only in the finest details of structure (such as the arrangement of the connective tissue in the tail-fin of the dolphin), but also in the makeshifts which the organism produces to make up for injuries to its original structure (as, for instance, the structure of the bone in the case of knee anchylosis).

The huge second volume is devoted to the subject of the "Mechanics of Development," of which study Prof. Roux may, as we have said before, be regarded as the founder. A considerable portion of the volume is taken up with replies to the successive publications of Driesch and Hertwig, who have pursued this branch of zoology with such brilliant success. Prof. Roux has only himself to thank if more attention is paid to the publications of these observers than to his work; for he has carried in this subject theorising and prolixity to an intolerable excess. The main difference between Driesch and Hertwig on the one hand, and Roux on the other, may be briefly stated: the former maintain that in the segmentation of the egg, we have a process which is essentially a mere multiplication of nuclei, all of which are similar to each other; the relative position of these nuclei determines what organs of the body they will eventually help to form; if their relative positions are altered by pressure or other mechanical means, their respective fates will be altered; or if one of the first eight segments of the egg be separated from all the rest, it is still able to form all the organs of the adult. Roux, on the other hand, maintains that by the formation of the first four segments of the frog's egg, the materials which are capable of differentiating themselves into the right and left sides and anterior and posterior halves of the animal are separated from each other, and that if one of the first two segments of the egg be severely injured, the other will develop into a half blastula, and eventually a half gastrula, and even further; the missing half will, however, be regenerated by the "reanimation" of the wounded blastomere by the migration of nuclei from the developed side.

It is of course extremely probable that in the normal course of development, the first segmentation furrow may coincide with the future long axis of the embryo, and if this is the case, the second furrow being at right angles to the first, will necessarily divide the egg into halves, one of which will be anterior and the other posterior. The question, however, whether this coincidence is essential or accidental, can only be settled by forcing the egg into such positions that the direction of the furrows dividing the segments is altered, and then observing whether the developmental history undergoes a corresponding alteration. Driesch and Hertwig have done this, and laid a strong foundation for their view, that the segmentation nuclei can be shaken together like a bag of balls, and still normal development ensue; and in the case of echinoderms and amphioxus, their theory, it seems to us, has been proved up to the hilt. Hertwig has written also a

paper on the development of the frog, in which he denies altogether the interpretations which Roux puts on his observations; he maintains that all which happens when one of the first two blastomeres of a frog is injured, is that the wounded side is delayed in its development. If the two segments are nearly separated from each other, each pursues its development as if it were a complete ovum. Roux's answers to these statements are two-fold: first he affirms that Hertwig, through not exercising continuous observation, missed the semigastrula stage, and only saw the embryo after the "post-generation" or "reanimation" of the wounded half had set in; and with respect to Driesch's work on echinoderm eggs, he suggests that by separating the segments or subjecting the egg to pressure, the normal machinery for bringing about the development is upset, and a special regenerative machinery, the reserve "idioplasson," brought into play; this occurs at a later period in the frog, but from the very beginning in the echinoderm.

It seems to us that with regard to the first point, Roux still holds the field; although we await with interest further observations on this subject from such a distinguished zoologist as Hertwig. It is *à priori* clear that in the ordinary course of affairs one blastomere gives rise to half the embryo; and as there are a large number of gradations conceivable between completely killing one blastomere, and only slightly checking its growth, there must be some point at which it is determined whether the remaining blastomere shall develop as a whole egg or in its normal manner. We cannot avoid the suspicion that Roux's semigastrulæ are conditioned by the contact of an actively developing half, with a stunned but not killed blastomere, whose influence is sufficient to prevent the other half acting as a whole egg. On the other hand, Roux's reply to Driesch seems to us extremely feeble. To assume that by slightly altering the conditions of a developing egg an entirely new machinery is brought into play, is not only an altogether unproved gratuitous hypothesis, but it is an attempt to discount any evidence which may be gathered from physiological experiments on eggs which behave differently to those of the frog. When the hypothesis of "mosaic development" or "self-differentiation" requires bolstering up in this fashion, it must be in a bad way.

The second volume contains a considerable number of papers, comprising the whole of Roux's work on the frog's egg. Besides the important and fundamental points we have mentioned, we find Roux's contribution to the vexed but still unsettled question of the nature of gastrulation, also some extremely interesting observations on the effect of alternating electric currents on the unsegmented and segmented egg. As the conclusion of the whole matter, Roux takes up a position decidedly opposed to the theory of epigenesis; he is in the main an evolutionist, though he admits that for the complete development of the organs from their embryonic rudiments the functional stimuli are necessary. Driesch has also proclaimed himself an evolutionist, though he points out (what Roux seems to us to forget) that in dealing with the facts of biology we must proceed inductively, and not set out with preconceived ideas as to the constitution of living matter.

E. W. M.

THE INDIAN CALENDAR.

The Indian Calendar, with Tables for the conversion of Hindu and Muhammadan into A.D. dates, and vice versâ. By Robert Sewell, late of her Majesty's Indian Civil Service, and Saukara Balkrishna Dikshit, Training College, Poona. With Tables of Eclipses visible in India, by Dr. Robert Schram, of Vienna. Pp. (including index) 169; tables, &c., cxxxvi. (London: Swan Sonnenschein and Co., Ltd, 1896.)

ALTHOUGH to many persons the chief interest of this publication (which must have cost the authors an amount of labour simply enormous) will be in an antiquarian and historical point of view, it has another aspect, judicial and practical, which was the immediate cause for its appearance. Documents bearing dates prior to those given in any existing almanac are often produced before Courts of Justice in India as evidence of title; and as forgeries, many of which are of great antiquity, exist in abundance, it is necessary to have at hand means for testing and verifying the authenticity of such documents when brought forward. Prof. Jacobi, Dr. Schram, and others, have within the last ten years thrown much light on the subject of the Indian methods of time-reckoning; but as their labours are only to be found scattered in scientific periodicals, the results are not readily accessible to officials and others to whom they are of importance in enabling them to determine questions in which the calendar, or rather calendars, observed in different parts and amongst the different peoples of that vast territory known as India, play an important part. Hence the Government of Madras requested Mr. Sewell to undertake the formation of a summary of the subject, accompanied by tables for ready reference. That gentleman not only accepted the task, but enlarged the scheme (which rendered it of a kind only to be called herculean) so as to make it include in its scope the whole of British India; and it has received the recognition of the Secretary of State for India. But besides containing a full explanation of the Indian chronological systems with the necessary tables for the conversion of their dates into ours, and *vice versa*, the volume is enriched by a set of tables of eclipses, most kindly furnished by that great authority on the subject, Dr. Robert Schram of Vienna. In the earlier stages of his undertaking, Mr. Sewell had the assistance of Dr. J. Burgess, late Director-General of the Archæological Survey of India. Afterwards he entered into correspondence with Mr. Saukara Balkrishna Dikshit, of the Training College at Poona, and it was agreed that the work should be completed under their joint authorship. The elaborate introductory treatise is mainly by Mr. Dikshit; several explanatory paragraphs, however, particularly those relating to astronomical phenomena, having been added by Mr. Sewell, who acknowledges the assistance received from Prof. Turner of Oxford, Prof. Kielhorn of Göttingen, and Prof. Jacobi. The tables of the latter were published in numbers of the *Indian Antiquary*, and Mr. Dikshit states that his calculations were, to a large extent, based upon these, though the original scheme had been propounded by M. Largeteau. We do not propose to enter into details here, which cannot be made interesting to the ordinary reader.

A great French astronomer once remarked that the only thing which made his head ache was the lunar theory; and scarcely less tiresome are calendar investigations. All honour, then, to those who do not shrink from these calculations. The last part of the work before us contains Dr. Schram's tables (formed by his own "Tafeln zur Berechnung der näheren Umstände der Sonnenfinsternisse" from the late Prof. Oppolzer's well-known "Canon") of the circumstances of all the eclipses visible in India and its immediate neighbourhood from A.D. 300 to 1900. It had been intended that these should be accompanied by maps, showing the centre-lines, across the continent of India, of the phenomena in question; but it was not found possible to complete these in time, owing to the numerous calculations that had to be made in order that the path of the shadow might be exactly marked in each case. Dr. Schram hopes, however, to be able soon to publish the maps separately, as they will form a very useful guide to the tables.

The different eras adopted in Hindu chronology form a somewhat troublesome subject. Those of Vicramaditya and Salivahana are largely used in the northern and southern provinces of India respectively, the former commencing in B.C. 57, the latter in A.D. 78 of our reckoning. But in Bengal, and some other parts, eras are used, the epochs of which seem to have been derived from that of the Hegira, or, as our authors prefer to spell it, Hijra; but by preserving solar time and the sidereal year preferred by the Hindus, the dates of these differ from those actually employed in the Muhammadan calendar. This is, however, of course itself now one of those used in many parts of India since the Muhammadan conquest, and is therefore included in the work before us. It is, as is universally known, reckoned from the flight of Muhammad from Mecca to Medina, which took place, by our chronology, on July 15, A.D. 622. In principle it is essentially lunar, the year being made to consist of twelve lunar months, or about 354 days; by the use of common and intercalary years (nineteen of the former and eleven of the latter in a cycle of thirty years), the length of a year is, in fact, maintained at 354·367 days. As this is 10·875 days short of a true tropical year, the Muhammadan year retrogrades through all the seasons in about thirty-three years. Had its length been the same as that of ours, the year of the Hegira would now be 1274, whereas their year 1314 commenced on June 12 in the present year (1896). We must demur to one statement (p. 40, note) of our authors: that in Christian chronology it is somewhat uncertain whether the years are current or expired. No doubt those who have not studied the matter are sometimes confused in the backward and forward reckoning by there being no year 0, which is neither B.C. nor A.D. But there is no uncertainty as to what is really meant. The years are reckoned from Christ's birth, supposed originally (but erroneously) to have taken place at or near the end of B.C. 1. At the end of A.D. 1, therefore, one year had expired, and at the end of 1895 that number of years. Ordinary people are sometimes puzzled by the simple question when a given century ends, but there is no real doubt or uncertainty in the matter; the present century will end at the end of December 31, 1900, and the twentieth will commence on January 1, 1901.

W. T. LYNN.

DOMESTICATED ANIMALS.

Domesticated Animals: their Relation to Man and to his Advancement in Civilisation. By Nathaniel Southgate Shaler, Dean of the Lawrence Scientific School of Harvard University. Pp. 264. Illustrated. (London: Smith, Elder, and Co., 1896.)

THOUGH the literature upon domesticated animals is of immense extent, we are unable to call to mind any work in which the subject is approached from quite the same general standpoint as in this suggestive book of Prof. Shaler's. The greater part of the volume consists of a series of essays on the dog, horse, poultry, &c., and even insects, so far as any insects can be said to be domesticated, reprinted with some amplifications from *Scribner's Magazine*, and written in a far more philosophical manner than is customary on such a subject. The leading idea, the connection between the practice of domesticating animals and social evolution, has of course not been neglected by sociologists; but it is discussed, together with the causes which have led to the selection of forms for domestication, and their consequent mental and physical modifications, in a manner well suited to attract the general reader who is a lover of animals, and to give an idea of the important part which their domestication has played in human progress. It is for him, rather than the man of science, that the work is intended; it is not detailed in treatment, and is in part covered by the writings of Darwin and Romanes. A good example of Prof. Shaler's method is afforded by the line of argument in which he points out that the invention of the horse-shoe made possible the disciplined use of the horse in Western Europe, and its differentiation into breeds. This led to the development of the war-horse, which played an important part in the warfare between Christian and Mohammedan States, as at the Battle of Tours, and promoted the institution of organised armies, and consequently of centralised States. Referring to the necessity of horses in military operations, he makes the curious deduction that China is unlikely ever to become a menace to outlying countries, because she cannot, and may never be able to, provide the horses necessary for the use of invading armies.

There is no mention in the book of the reindeer, surely a very important factor in the economy of the races which use it. On the vexed question of the origin of the dog, it is noteworthy that the author does not recognise it as the descendant of any surviving wild form.

The closing chapters on "The Rights of Animals" and "The Problem of Domestication" are published for the first time. In the former, the author, a strong and genuine sympathiser with animals, defends the practice of vivisection within proper limits. "So far from natural science tending in any way towards cruelty, it has been the very guide in the development of the modern affection for living beings. By showing something of the marvels of their structure and history, it has increased in a way no other influence has ever done the conception which we form as to their dignity and the wonderful nature of their history"; a point both true, and usually disregarded. Like every naturalist, Prof. Shaler deplores the rapidly advancing extermination of animal types.

particularly among the larger kinds, and offers various suggestions, both as to increasing the number of domesticated forms and the conservation of wild species in reservation-areas, such as the Yellowstone Park. Valuable as many of his proposals are, it is to be feared, in the present relation of natural science to bodies politic, that they are somewhat of an utopian character. It is not easy to maintain such areas under entirely natural conditions and free from interference, administrative or otherwise. To take a small instance: it is notorious that in the New Forest, perhaps our nearest approach to such an area, the insect-population has greatly diminished during the last thirty years, and many rare and retired species are on the point of extinction.

In the artistic, though somewhat unequal, illustrations, and the excellence of printing and paper, the book is worthy of high praise. W. F. H. B.

OUR BOOK SHELF.

A Geological Sketch Map of Africa South of the Zambesi. By E. P. T. Struben, F.R.G.S. (London: Edward Stanford, 1896.)

THE chief object of this new map, and accompanying pamphlet, of South Africa is to show that the Witwatersrand beds occur over a large portion of Africa south of the Zambesi. The band of dolomite, already described by Mr. Draper, is used by the author as a means of identifying the various scattered portions of sandstones, conglomerates, &c., occurring in South Africa, and which in many localities have proved to be auriferous. That the auriferous strata of the Rand occur outside the Transvaal is an established fact; but Mr. Struben hardly brings forward enough evidence to show that the sandstones, conglomerates and dolomites, recognised by him as identical with the Witwatersrand beds, are really all of one age.

The table of strata is very meagre in detail; the formations recognised being "Granite, Carboniferous beds, Sandstones, Shales and other stratified rocks, and Limestone." The formations are too much lumped together to be of much service, and there remains a doubt that the dolomite limestone mentioned by Mr. Struben is of various ages. A strip of crystalline limestone is represented near the coast north of the Umzimkulu River, and coloured similarly to the dolomite, but no mention is made of the cretaceous rocks of the east coast. There is no attempt made to show the relationship of the Rand beds to the Dwyka conglomerate, the Zwaartebergen quartzites, and the older rocks of the Cape. The metamorphic schists underlying the formations of South Africa are not mentioned. The relation of the Rand beds to the coal-bearing strata is also not clearly stated. In Natal the relationship is drawn as one of perfect conformity; but it is certain that in the Transvaal the coal-bearing rocks are unconformable to the Rand beds, and of much more recent date.

Mr. Struben's map, as showing the localities in which the minerals occur in South Africa, is valuable, but it does not approach in scientific value to Dunn's map of South Africa. The stratigraphy of South Africa is extremely complex, and a solution can only be arrived at by a survey, such as was commenced by Dunn, Griesbach and Stow.

Wayside and Woodland Blossoms. A Pocket Guide to British Wild Flowers for the Country Rambler. (Second Series.) By Edward Step, F.L.S. Pp. 170. (London: Frederick Warne and Co., 1896.)

WE are glad to know that the first volume published under the same title as this has met with the success it deserves, and we hope the present pocket-book will have a similar welcome extended to it. Four hundred species of flowering plants were described and illustrated in the first series, which Mr. Step now supplements with descriptions of 325 species, 130 being represented upon coloured plates, while 23 are shown in black and white. The plates render the identification of a plant a comparatively easy matter, and the clear descriptions of the plants are worthy accompaniments to them. Mr. Thiselton-Dyer should rejoice at the opportunity which the book affords every one to learn something about botany from "wayside and woodland." It will be remembered that as president of the botanical section of the British Association last year, he condemned the system of botanical teaching followed in many schools for examination purposes, and pleaded that the subject should be developed as an educational instrument. In the course of his address he said: "The modern university student of botany puts his elders to blush by his minute knowledge of some small point in vegetable histology. But he can tell you little of the contents of a country hedgerow; and if you put an unfamiliar plant in his hands, he is pretty much at a loss how to set about recognising its affinities." Mr. Step's book provides such students with the materials to make up their deficiencies; it is a book which will develop the observant faculties in young students of natural history, and one which will make more lovers of botany than all the examination syllabuses and text-book formulas yet devised.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Fine Shooting-Star; and Heights of Meteors in August and November 1895.

A REMARKABLY bright shooting-star was seen here on Saturday, June 13, at 10.59 p.m., under such favourable conditions of a clear sky and warm calm air on that evening, that it may possibly have happened that other notes were kept of its appearance, in the South of England, by astronomical observers. It was not a large-sized fireball, but in its course of about 30° it increased quickly from the brightness of a 1st mag. star to that of Sirius and of Jupiter, and just before its disappearance it shone with a short white flash as bright as Venus, which lit up the sky quite distinctly to about 20° or 30° from its final bright expansion. The head was white, free from sparks, and left along the greater portion of its course a yellow streak of light, of which a portion 8° or 10° in length was visible 10 seconds, while a shorter piece, 3° or 4° long at the end of that, where the bright flash occurred, growing white and misty by degrees, remained visible for 40 seconds. Duration of the flight about 2 seconds; from 230°, + 20° to 208°, − 4°; the patch of long-enduring streak extending about from 212°, ± 0°, to 209°, − 3°.

This track is directed from the head of *Andromeda;* and albeit the meteor greatly resembled a bright August Perseïd in appearance, of which shower first members have been traced as early as the beginning of July, proceeding from radiant-points in much lower R.A. than the chief centre of the system, yet the displacements of this meteor's course in time and in position from the main stream of the Perseïds are too considerable to allow an explanation of its appearance of that kind to be proposed as a probable conjecture. But there are no less than four ordinary radiant points, all active at this time, as Mr. Denning has informed me, in *Cygnus*, *Lacerta*, and *Honores Frederici*, in the "List of 918 Radiant-points" which he has published in the Astronomical Society's *Monthly Notices* (vol. 50, p. 410, May 1890), at distances back along the line of flight, of 55°, 70°, 80°, and 100°, from which its flight was directed accurately; and it is from the last of these slender meteor-sources (No. 174 in his List), at 354°, + 39°, about 5° south of ι, κ *Honorum*, a centre of swift, long-pathed, streak-leaving meteors in June and

July, with a fine Venus-like shooting-star just similar to this present meteor (its streak remaining visible 5 secs.), observed at Bristol on June 14, 1887, among them, that Mr. Denning considers it most probable that the real course of this bright meteor was directed. Its path and that of the just similar one observed at Bristol, prolonged backwards, intersect each other at 354°. + 36°, close to this well-marked shower-position; and if additional notes of the meteor have been obtained at other stations, it will be an interesting question to examine if they bear out this conclusion.

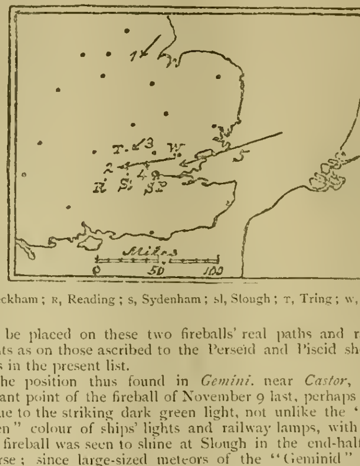
I take this opportunity of the returning abundance of meteors of the August period to beg to correct some errors of calculation and projection in my letter on "Heights of August Meteors" in NATURE of September 5, last year (vol. lii. p. 437), which gave confused descriptions, without, however, tripping (except slightly in the case of the second meteor) in the real values of the heights there found, of two meteors doubly observed at Tring and at Slough on August 11, 1895. The places over which the meteors were vertical when first seen, and at disappearance, were laid down in proper relation to Tring and Slough on a map of England, but from left to right instead of from right to left of the Tring and Slough meridian; so that although both their radiant-points were really easterly, their paths were described as from Oxfordshire to Middlesex, and from west to east across the northern part of Buckinghamshire, in my letter. The corrections applied to the observed paths of the second meteor were somewhat incorrectly chosen, and gave thereby resulting heights and a length of path which were somewhat faultily arrived at; while the radiant-point of this meteor (α Persei), given by the observations directly was a little departed from, and its altitude and azimuth were also given as 45°, 34° north of east, instead of 35°, 44° north of east. As uncertainties from errors inherent in meteor-observations (rarely very small ones) are unavoidable in comparing them together, a recalculation of both paths will, it seems probable, serve better to correct this maze of errors and mistakes, than to try to rectify individually the above principal ones, and a few lesser faults which the paths deduced last year contained.

Two other accordances, of a Perseid shooting-star between Tring and Slough, and of a small fireball between Tring and Sydenham, in August last, and one of a rather notable fireball in November last, have afforded, since the path-descriptions in my former letter, some fairly good materials for height-determinations, although the data of the two fireballs' paths are of a little looser kind than those of the two foregoing and the one now newly-added shooting-stars. In the accompanying table I have grouped together what appear to be the real courses (including the two shooting stars' recalculated paths as Nos. 2, and 3, in the table), of all the meteors found here to have furnished accordant observations in last August and November; and I may add, in gladly expressed acknowledgment of the aid supplied abundantly by accuracy of the original observations to the general certainty of these determinations, that nearly all the present list of meteor-heights (only excepting those of the fireball of November 9) is due to some weeks' actively continued watch, with careful records of descriptions and well-mapped courses by the stars, successfully maintained at Writtle and at Tring by Mr. J. A. Hardcastle in order to obtain them, on the Perseids and occasional meteor-members of other showers more or less conspicuous during the period of the display from Perseus, in August last.

In cases of loose, and of partially inconsistent descriptions, much latitude of choice is left to adjust the observed tracks to each other; but the limits of this choice become, in general, narrowly restricted if the ordinary descriptions and characters of meteor-flights are kept in view, and if any wholly improbable results, as of rising upwards, or of paths abnormally at variance with the usual heights, and not reconcilable with the acknowledged astronomical velocities of meteors, are rejected. The course of the fireball No. 5, of November 9, descending almost vertically in E.N.E. at each of the stations, Peckham, Slough, and Reading, where it was observed, along nearly the same apparent path (but beginning at those stations at nearly equal, and ending at very unequal altitudes), was situated so unfavourably for determining its radiant-point by the observed paths' mutual intersections, that only the ordinary conditions of meteor flights (attained to here by trial and error combinations of more and more appropriate paths to satisfy them and the tolerably accordant observations also) could be usefully resorted to as the sufficient additional criterion needed to define the radiant-point, or the line of real direction of the meteor's course.

The observed paths at Writtle and at Slough of the Perseid shooting-star, No. 1, are also in the unfavourable position of nearly "fore-and-aft" conjunction, but deviate sufficiently from it to yield the radiant-point noted in the list, by their mutual intersection, and from the heights, and meteor-speed given in the list, which are computed from it, this position of the point appears to stand in no further need of very material amendment by the proof test of the atmospheric and astronomical criterion.

In the case of the small fireball No. 4 (if the same meteor, as assumed from their resemblance, was really referred to in both the observations), besides a pretty large divergence from parallax direction between the two path-positions, making a rather considerable reconstruction of them both essential, a nearly lengthwise conjunction (as in Nos. 1, and 5) also once more occurs, introducing a large uncertainty, scarcely less than in the case of the fireball No. 5, into the position of the radiant-point, and into the consequent heights and length of path computed from it; which could only be overcome, as is done, it is to be hoped successfully, by the same tentative method of proceeding as that which was used to fix the real path and radiant of that latter fireball. With heights not far removed from sixty miles, and speeds not far from parabolic ones admitted, the construction's freedom becomes so greatly narrowed in these two fireballs' otherwise most equivocal-looking cases, that nearly as great, though (by unadjustable differences in the observations) still questionable dependence



P, Peckham; R, Reading; S, Sydenham; SL, Slough; T, Tring; W, Writtle.

may be placed on these two fireballs' real paths and radiant-points as on those ascribed to the Perseid and Piscid shooting-stars in the present list.

The position thus found in *Gemini*, near *Castor*, of the radiant point of the fireball of November 9 last, perhaps affords a clue to the striking dark green light, not unlike the "signal green" colour of ships' lights and railway lamps, with which the fireball was seen to shine at Slough in the end-half of its course; since large-sized meteors of the "Geminid" shower diverging between the end of November and the middle of December from the immediate neighbourhood of the fireball's radiant-point position so determined, are notable for frequent occurrence of green hue in their nuclei. The low height of eight miles assigned to the meteor at its disappearance would nearly break record[1] of a fireball's deep penetration towards the earth before extinction, if the extraordinarily bright detonating fireball of December 14, 1890, had not been shown undoubtedly to have ended its shining course at not more than seven or eight miles above the earth, and that, too, by a curious coincidence, like the present meteor's end-point, over Billericay or some place close to Billericay, in Essex! Should observers in that latter county, or in any of the adjacent East Coast districts, have noted particulars of its appearance on November 9, which happened on a clear night during a prolonged display of a widely-observed and rather fine aurora (and, though the memory is a sad one to recall, especially on a date which was an annual one of rejoicing

[1] The fireball which accompanied the fall of aërolites at Weston, Connecticut, in the United States, on December 14, 1807, was found by Dr. Bowditch to have remained luminous in its descent until only about three or four miles above the places on the earth's surface where the aërolites were scattered.

Table of observed Paths and Real Heights and Radiant Points of Meteors doubly observed in August and November 1895.

No.	Place; observer.	Date. 1895.	Hour. p.m.	Mag. by Stars, &c.	Colour.	Duration. Secs.	Length of path.	Apparent course and (do. corrected). From α	From δ	To α	To δ
1	Writtle, Essex; J. A. Hardcastle.	Aug. 6	11.26	>1	Blue	Swift	10° (10)	170° (162	+ 70° + 72	187½° 186	+ 62½° + 63½)
	Slough, Bucks; A. S. Herschel.	6	11.26	>1	White	0·7	6 (7)	97 (97	+ 68 + 69	117 120	+ 71 + 71)
2	Tring, Herts; J. A. H.	11	9.53	1; streak	—	2 or 3; slow	33° (35)	332½ (327	+ 39° + 41	287½° 279	+ 42½° + 40½)
	Slough; A. S. H.	11	9.53	1; streak 3 secs.	White	1·2	37 (35)	331 (335	+ 53 + 50	268 277	+ 51 + 54)
3	Tring; J. A. H.	11	11.3	Streak	—	—	12° (16)	345° (337	+ 58° + 57	325° 315	+ 53° + 49)
	Slough; A. S. H.	11	11.4	3	—	0·6 ±	10 (9½)	350 (359	+ 72 + 71	312 324	+ 70 + 71)
4	Tring; J. A. H.	19	9.32	>Vega	Blue	2 ±	22° (24)	317½° (310	+ 37° + 42	320° 322	+ 15° + 18)
	Sydenham.*	19	9.25 ±	Very bright star	Blue, then red	5 ±	Almost stationary (4)	⅓ (Zen. ζ Urs. Maj.) 248 (273	 + 63 + 65	 248 262	 + 63 + 66)
5	Reading; G. T. Davis.	Nov. 9	10.45 ±	>3′ diameter; = ¼ ☽	Orange-yellow	3 ±	12° in sight (17)	113° towards β Cancri (further) to (115	+ 26° + 27	120° 122 122½	+ 15° + 10 + 11½)
	Peckham; H. Lawton.	9	10.40 ±	Bright fire-ball	—	—	10 ± (11)	From a little left of α, β Gem. acr. ⅓ (β Gem., ♃) (112	 + 34	 120	 + 23½)
	Slough; A. S. H.	9	10.47	10 × ♀ ±	Orange, then green and red	2¾ or 3	22 (17)	113 (112½	+ 31 + 30	119 118½	+ 9 + 13½)

No.	Radiant-point (corrected) α δ and Az Alt. and by nearest stars.	Real heights in miles at first appearance and disappearance.	Places vertically under the points of appearance, and disappearance.	Length of sloping path, in miles.	Observed speed; miles per second.	Parabolic speed; miles per second.
1	59 + 49° 42 E. fr. N. 34 λ Persei	72 59	½ (Spilsby and Kirkstead), Lincolnshire Near Gt. Ponton (by Grantham), Lincolnshire	29	42	39
2	23 + 9 11 N. fr. E. 5 o Piscium	82 76	Colford, near Chelmsford, Essex Great Marlow, Bucks	53	44	41·5
3	48 + 50° 43 N. fr. E. 31 α Persei	53 43	Hitchin, Herts Near Berkhamstead, Herts	19·5	32 ±	40
4	286 + 62 10 W. fr. N. 78 ½ (o, π) Draconis	60 26	½ (Barnet and Watford), Herts Sudbury, Middlesex	35	17	20
5	110 + 36 19 N. fr. E. 34 α Gemin., 4° north	68 8	In the North Sea, 45 miles E. from Hollesley, Suffolk Billericay, Essex	107	39	39

* The *English Mechanic*, August 23, 1895, vol. lii. p. 1[illegible].

in England and for the metropolis, only a few minutes before the occurrence of the terrible railway accident at Grantham on that night), I would be glad to know if they confirm the near approach to earth over the Brentwood Hills (as the end-point), and the position near Castor (as nearly the point of first appearance), assigned by this discussion to the meteor's flight; or if, as seen much sideways from its plane of fall, in counties north of Essex, the meteor's apparent line of flight may have been but little accordant perhaps, or even, quite possibly, not at all conformable with these sky-positions?

With regard to Mr. Denning's identification of the course of the above described bright meteor of the 13th inst., with a radiant-centre near *Honores*, I may mention in concluding that on the 19th inst., at 11.56, I noticed here a long-pathed streak leaving, 2nd mag. meteor shoot swiftly (about 30° in $1\frac{1}{4}$ sec.) from 195°, + 68°, in *Draco*, to 181°, + 39°, in *Canes Venatici*, leaving a thin white streak for $2\frac{1}{2}$ seconds along its whole track. This course prolonged backwards about 60° proceeds from 350°, + 37°, only 3° or 4° from the place at 354°, + 39°, of the radiant No. 174 of Mr. Denning's list; and like the brighter shooting-star of June 13, it evidently belonged to this same June "Honorid" system. Mr. Denning's outline of the shower's duration, through the latter half of June and the first week of July, with a date of maximum on June 26, would thus seem, for this year's return of its meteor-period at least, to be in a fair way to be realised. A. S. HERSCHEL.

Observatory House, Slough, June 20.

Purification of Sulphur.

IT is never a very pleasant or gracious task to reply to criticism. When that criticism, however, is based on a misapprehension of the facts, and is consequently wrong and misleading, and is, moreover, enforced by whatever weight "authority" may carry, its correction is simplified down to a plain matter of duty. The criticism to which I refer is contained in Prof. Armstrong's address to the Chemical Society (*Chem. Soc. Journ.*, vol. xxxix. p. 1160), which has just come before me.

The passage to which I refer runs as follows. "To return to sulphur, an abstract account has recently been published in the *Proceedings* of the Royal Society (1894, lvi. 32) of observations by Threlfall, Brearley and Allen, on the electrical properties of pure (*sic*) sulphur, *i.e.* sulphur from the Chance recovery process purified by distillation and exhaustion in vacuo. Such a process cannot be accepted by any means as an exhaustive one, and it appears almost to be a case of 'love's labour lost' to apply to such material the infinite care which the authors appear to have taken in making the electrical measurements. Yet they arrive at the important conclusion that so long as a single modification be dealt with, such sulphur does not conduct while solid. A mixture of two modifications, however, does; but in view of the possibility of changes taking place during the production of the mixture, of conducting impurities being introduced or generated, it is difficult to regard this latter conclusion as established; the more so as the authors in question have found that, as the temperature was raised the conductivity of the sulphur increased slightly up to the melting point, when there was an enormous increase."

Prof. Armstrong prefaced the paragraph which I have quoted above, by some rather ungenerous remarks as to the supposed attitude of physicists towards the question of chemical purification of material. It is now eight years since I began to endeavour to purify materials, so that I can, at all events, agree with Prof. Armstrong on one point, viz. that it is much more difficult to purify a substance up to the furthest limit of chemical discrimination, than it is to determine its physical properties afterwards. In the passage to which I now allude —and which I do not intend to quote, for I feel sure that Prof. Armstrong will, on consideration, agree with me that it is better forgotten—the "tongue of the scorner" is thrust out at those physicists who take no thought as to the condition of material examined by them. However true this may once have been, I am sure that nowadays it is a mere superstition to suppose that physicists, as a body, are callous on the subject of purification. A great deal of modern work in this domain of chemistry has been done by professed physicists; and indeed, though I have myself known several physicists enormously interested in questions of purification, I have only known one chemist whose life-long endeavour was to get things pure, and that was the late Prof. Josiah P. Cook, of Harvard. Passing to the immediate point, Prof. Armstrong objects to the use of the word "pure," made by myself and my co-workers. With regard to this, I may say that Prof. Armstrong labours under the disadvantage of only having an abstract under his notice. In the paper (if it ever gets published) he will find that this very matter is discussed at, perhaps, too great a length, and the conclusion arrived at that the word "pure" ought to be kept for substances in such a degree of purity that existing chemical or physical means fail in discovering any foreign substance. "Pure," therefore, as we have used the word, has no meaning except in connection with the existing state of the art of chemistry, and was adopted by us rather than the word "purified," as the result of some consideration, in which a desire to avoid pedantry had some weight. Since Prof. Armstrong refers eulogistically to Stas—as who would not—I may perhaps refer him to the following passages by Stas himself (*Bulletin de l'Académie Royale des Sciences, &c., de Belgique*. 2 séries, vol. x. p. 253), than whom no one could be more careful as to the use he makes of the word "pure."

"Jusqu'ici, il n'y a que M. Dumas qui ait tenté de faire la synthése du sulfuré d'argent. Pour déterminer le rapport proportionnel de ses éléments, il a sulfuré directement l'argent par *du soufre pur* qu'il faisait passer en excès." . . . "En suivant cette méthode, j'ai fait deux séries d'expériences: la première, comprenant trois synthèses par *du soufre pur* amené en excès." Stas gives no details as to the preparation of his "soufre pur" (which he would certainly have done had elaborate precautions been taken); and as a matter of fact, Stas' sulphur was probably far less pure than mine, for in those days there was no "Chance" sulphur. So much for the word "pure."

Prof. Armstrong considers that the process of purification employed by us is "by no means an exhaustive one," &c. A process is, we take it, exhaustive when it exhausts the resources of physics, including chemistry. Now, we spent four years in trying all likely and many unlikely methods of purification. We finally, by sheer good fortune, received some Chance sulphur, and our methods of discrimination at once revealed to us that, when dust and water were removed, it was purer than any we had been able to prepare hitherto by the most elaborate means; and we adopted it as our source of sulphur in consequence of this discovery. On the other hand, there are doubtless degrees in the purity attained by the commercial product. The first lot we received (a present from Mr. Chance) was much purer than some afterwards purchased; and with this later sample the process we employed for purification would probably not have been sufficient.

With regard to the question of the adequacy of the purification—for this is the important point—we arrived at a stage at which no chemical means enabled us to detect any impurity whatever, and the specific resistance (if one may so misuse the term for a body which does not obey Ohm's law) rose above 10^{28} C.G.S. units; our limit of discrimination, and probably the furthest hitherto *certainly* attained.

As we had found that the purer the sulphur the better it insulated, as with this sulphur we could absolutely find no impurity at all, and as all our means of purification (except by repetition) were exhausted, we felt that we had done all that could possibly be done.

The conclusion at which we arrived—viz. that so-called mixtures of crystalline and amorphous sulphur conduct, whereas pure crystalline sulphur does not—seems to us to be of considerable importance, and we therefore spared no pains to assure ourselves of its truth. For this purpose we prepared crystalline sulphur films, ascertained their property by non-conductivity, and then converted them into the conducting mixture by appropriate heating and cooling. Conversely, we caused conducting "mixtures" to become non-conducting by annealing. Prof. Armstrong's criticism, therefore, is wrong, and the uncertainty, which he assumes, does not exist. It is as certain that crystalline sulphur is at least about a million times more non-conducting than "mixed" sulphur, as that copper conducts better than glass. We spent some years in assuring ourselves of the truth of this proposition, and we feel that we should be shirking our philosophical duty were we to allow this conclusion, so laboriously reached, to be set aside, or rendered nugatory, by a criticism based on a misapprehension, and enforced by all the weight which Prof. Armstrong's utterances so rightly carry.

I confess I am unable to reply to that part of Prof. Armstrong's criticism in which the above conclusion is supposed to

be in some way dependent on the fact that any variety of sulphur increases in conductivity with rise of temperature. Unless it is suggested that we did not know one temperature from another, I fail to understand this criticism. RICHARD THRELFALL.

University, Sydney, N.S.W.

I SEE no reason to recall what I have said regarding the general attitude of chemists and physicists on the question of the influence of minute traces of impurity; and when I come across the remark in Messrs. Threlfall, Brearley and Allen's paper in the *Phil. Trans.*, that "it is not too much to say that the electrical action of most bodies in a pure state is entirely unknown at present," I feel there is not much difference of opinion between us.

Then, as to my being guilty of that unpardonable crime—pedantry—it has always seemed to me that those of us who undertake scientific work should also strive to be scientific, *i.e.* exact, in their use of language. Those who had the great good fortune to be present a year or so ago at the NATURE dinner, and to hear Huxley's marvellous speech—almost, if not the last he delivered—will recollect how strongly he insisted on the importance of greater care being taken in the writing of papers describing scientific inquiries. In a conversation I had with him afterwards, he greatly lamented the careless manner in which such work was too frequently done.

Now if *pure* mean "free from mixture," a pure substance must, as I have said, ever remain an ideal conception; the purist must ever regard all things as impure. Prof. Threlfall tells us that "the word pure has no significance except with respect to a definite state of the art of chemistry." I would rather accept the meaning which is to be found in the dictionary, *pace* Stas even; and would prefer to assert that the word too frequently has no significance except with reference to an indefinite state of the mind of the person—chemist or physicist—using it. To my mind, there can only be degrees of impurity—not of purity.

Whatever time Prof. Threlfall and his colleagues may have spent in seeking to purify sulphur, the fact remains that their experiments were made with sulphur which they obtained by chance, and that the only method of purifying it they adopted was to distil it several times in vacuo, after filtering it while molten through glass wool and platinum gauze, and then to fuse it in vacuo—in order, they tell us, to get rid of gases (probably water vapour, they say) given off even from the purest samples. But distillation in vacuo, even when followed by fusion in vacuo, can scarcely be regarded as a process which "exhausts the resources of physics, including chemistry."

"Chance" sulphur is prepared by burning sulphuretted hydrogen. It is probably impossible to burn sulphur without producing some sulphuric acid. Messrs. Threlfall, Brearley and Allen, however, do not even refer to the possibility of its presence, and apparently took no precaution whatever to eliminate it, if present.

They tell us that on breaking up such sulphur after it had been strained while molten through glass wool and platinum gauze, it emitted a horrible smell of gas-lime, "which shows that it requires to be distilled if sure results are to be obtained." I imagine, therefore, that the sulphur they used initially was by no means so remarkably "pure"; as they also state that gases were given off even from the purest samples when fused in vacuo after distillation, it may well be doubted whether so simple a process as mere fusion could suffice to effect the necessary final purification.

Prof. Threlfall's statement that conducting "mixtures" were caused to become non-conducting by annealing, is apparently a good answer to my criticism; but by no means finally disposes of it. The structure of the two materials may have been very different, and such in the one case as to allow an impurity to act, which in the other case might be inoperative. By my reference to the conductivity of sulphur at temperatures above its melting point, I meant to imply that the behaviour described afforded indication of the presence of impurity; for I do not believe that even molten sulphur is a conductor. Of course, at present, this is but an opinion, but it may not be inappropriate to direct attention to the recent most remarkable observations of Dewar and Fleming on bismuth, showing that an amount of impurity altogether beyond detection by chemical means may entirely alter electrical properties.

I still, therefore, regretfully retain my opinion, and fear that, notwithstanding the great care lavished on the work of Prof. Threlfall and his colleagues, it will be necessary to repeat it, perhaps over and over again—a possibility which they apparently themselves foresee in the introduction to their paper—before so remarkable a conclusion as that they have arrived at can be regarded as established.

H. E. ARMSTRONG.

Increasing the Efficiency of Röntgen Ray Tubes.

MR. J. C. PORTER, in a letter in NATURE of June 18, describes a method of increasing the efficiency of a Crookes' tube. I have for some weeks used another very simple method to obtain the same result. This consists in placing the flame of a small glass spirit-lamp in the angle formed by the Crookes' tube and the wire passing to the kathode, and allowing a series of small sparks to pass to the flame from the wire.

Burnley, June 29. T. G. CRUMP.

THE POSITION OF SCIENCE AT OXFORD.

WHILST the study of natural science has been progressing rapidly in other universities and colleges during the last ten or fifteen years, it is a matter of common knowledge that it has progressed very slowly indeed in the University of Oxford. It would be incorrect to say that it has not progressed, for there has been during the last few years a steady, though very gradual, increase in the numbers of men reading for honours in the final school of natural science. In 1885 twenty-two men obtained honours in sciencce, in 1895 there were forty-three names in the class list, and a rather larger number in 1894. The school has just doubled itself in ten years, but for all that the numbers are still small, and out of all proportion to the provision that has long existed for science teaching in the University. It must be understood at the outset that the University, considered as a body separate from the colleges which compose it, has not dealt ungenerously with science. The staff of professors, and the emoluments attached to their chairs, compare favourably with those of any other university in Great Britain; and Oxford actually set the example, at great cost to itself, of building a museum and equipping laboratories for educational purposes. Moreover, the opportunities of scientific study in Oxford are greatly enhanced by the existence within the precincts of the museum of a first-rate scientific library, such as is not possessed by any other college or university in the kingdom. It is a strange thing that when it has so many advantages, Oxford has allowed itself to be completely outstripped in this particular path of intellectual progress.

It is the purpose of the present article to discuss the possible causes of comparative failure of the science school at Oxford. A complete failure it is not, for, however poor its numerical results may be, it has long been recognised that the attainments of the limited number of scientific men which it turns out compare well with those of men who have been educated in other places.

It is commonly supposed that the prime cause of the insignificant numerical result is the small encouragement given to scientific study in the shape of fellowships and scholarships; and those who hold this opinion believe that if the colleges were to do what is conceived to be their duty in this respect, the science school would progress by leaps and bounds.

With respect to scholarships and exhibitions, it is apparent, from an analysis of the figures, that science does not get what may rightly be held to be its due. The *University Calendar* for 1896 shows that there are in Oxford some 500 scholarships of an annual value of £80 a-piece, and in addition some 225 exhibitions, the annual value of each of which may be placed at £40, These figures apply only to college scholarships and exhibitions, and so it appears that the colleges, apart

from the University, exercise an intellectual patronage to the extent of nearly £50,000 per annum. How is this patronage exercised, and what share of it falls to natural science?

It is not unreasonable to say that bare justice would be done if the number of scholarships allotted to science bore the same proportion to the number of men reading for honours in that subject as the number of scholarships allotted to literary subjects bears to the number of men reading for the literary schools. This bare measure of justice is not done. In 1895 one hundred and fifty-three men were classed in the honour school of Literæ Humaniores (a number beyond all previous precedent); eighty-seven were classed in Modern History; sixty-six in the honour school of Jurisprudence; forty-three in Natural Science; thirty-seven in Theology; twenty-three in Mathematics; and one in "Literis Semiticis"; in all four hundred and ten. Deduct twenty from this number to exclude those who took a second final school, and there remain three hundred and ninety, of whom forty-three, or one ninth of the whole, belonged to the school of Natural Science. Science, on this reckoning, should claim fifty-five out of the five hundred existing scholarships. It is not very easy to ascertain the exact number of science scholarships, but there are certainly not more than forty. It appears from the *University Gazette* that in the academical year 1894-95 only ten out of twenty-one colleges offered scholarships or exhibitions in Natural Science, and that those ten have offered science scholarships for some years past. The ten are Balliol, Merton, New College, Magdalen, Christ Church, Trinity, Corpus Christi, Jesus, Keble, and Queen's. The scholarship at the last named, though in fact awarded to a candidate who offered Natural Science, was equally open to candidates offering Classics or Mathematics. In addition, St. John's offered and awarded a scholarship in mathematics and physics, either separately or in combination. As each of the ten colleges gave one science scholarship, and as the tenure of a scholarship is four years, it follows that there are only forty science scholarships in the University, or if St. John's be added, forty four—at the lowest computation ten less than there should be.

The paucity of science scholarships has been a frequent subject of comment; but the colleges have a ready and a very plausible answer, which is best illustrated by the fact that in November last Balliol did not award a science scholarship because no candidate of sufficient merit presented himself. It is a fact that the candidates for science scholarships are not only few in number, but also of low average merit; there are, of course, brilliant exceptions. It is not easy to fix a common measure for the intellectual acquirements of classical and scientific students, but as far as a comparison can be instituted, it is vastly to the advantage of the classical scholar. He is a better classic than his scientific confrère is a man of science, and is in addition more widely read and has a greater knowledge of subjects of general interest. The most that can be said is that the science scholar knows a little of classics, a classical scholar as a rule is profoundly ignorant of science. But in powers of expression, in the ability to handle an unfamiliar theme, and in range and variety of knowledge, there is simply no comparison. Hence the colleges justify themselves by saying that they award scholarships to candidates of the greatest intellectual merit, and it is their experience that the greatest merit is found in those who have had a classical education. As for science scholarships, the competitors, they say, are not worthy of the prize, and the prize is accordingly withdrawn, with the result that the number of science scholarships tends to diminish rather than to increase.

This is true, and it is a lamentable state of things, pointing to a serious deficiency in the secondary education which precedes and leads up to a University education. It is, however, remarkable that Cambridge, which gives plenty of science scholarships, finds no difficulty in getting candidates of sufficient merit. The explanation of this is probably somewhat as follows. At Oxford scholarships are nearly exclusively awarded to boys who are still at school; very few are open to undergraduates who have been in residence for more than one University Term. At Cambridge many scholarships are open to men of one year's standing, giving an opportunity to those who have come up to the University with a fair general education and only a moderate acquaintance with science, to learn enough science in their first year to bring themselves up to the standard of a scholarship; many at Oxford would be glad of such a chance, but it is not open to them. In the second place, the science school at Cambridge has acquired such a prestige that the best boys go there, and only the second best to Oxford; and thirdly, Oxford draws its undergraduates more exclusively from the great public schools than Cambridge does. Taken on the whole the teaching of science in public schools is bad. There are, of course, some exceptions, but they are rare, and in many science can hardly be said to be taught at all. It may be objected that every public school has one or more science masters of tried capacity, and that science is a compulsory subject in nearly all. It may be so, but the inducements offered to the study of science in public schools are very few; in most of them there are not only no inducements, but the study is openly discouraged. Boys are not generally inclined to give themselves unnecessary trouble over their studies, and are only too ready to neglect that which may safely be neglected; the science masters have no chance with the majority of them, and have to resign themselves to giving as much trouble and time as school regulations permit to the few enthusiasts who care to add science to their classical burdens. For all the pretence that public schools make of teaching science, the average schoolboy comes up to the University destitute of the most rudimentary scientific ideas. If, as is sometimes the case, he wishes to take up science on his arrival there, he has to begin with ideas and facts which he might well have learnt in the nursery; if he prefers a literary course, he remains to the end of his life as ignorant of the alphabet of science as any baby. There is room for considerable difference of opinion as to how far the technicalities of any branch of science should be taught to schoolboys, but it must be admitted that in this age, which is above all things an age of science, an understanding of the fundamental laws of at least physics and chemistry ought to form a part of that vague but cherished ideal "a good general education." But are the public schools altogether to blame? In our system of education the universities call the tune, and the schools may be excused if they only play what is called for. The universities do not call for science. They say in effect, "before you can be of us you must know Latin and Greek, and you must know a certain minimum of arithmetic and of algebra or of geometry, but of any knowledge of science you may be as innocent as a babe. We care nothing for it, and we will confer our highest distinctions on you without asking you for one syllable of it."

The gates to an Oxford career are the University examination, responsions, or more familiarly "smalls," which takes no cognisance of science, and the college matriculation examinations, which in only a few cases give it a bare recognition. So long as this is the case, science will not be seriously taught at the public schools, and there will be a dearth of adequate candidates for science scholarships. The justification of the colleges amounts simply to this—that by their system they have discountenanced the teaching of science in schools, so that the schools cannot send them candidates fit to hold

science scholarships, and therefore the scholarships are not awarded.

Oxford fosters the exclusive study of classics in the public schools, and it also does its best to shut its gates against those who have received what is called a modern education in other schools. The burden of matriculation and responsions is not a very heavy one to a fair classic, but it is sufficient to keep out many who have had an exclusively classical education, and is quite prohibitive to most "modern" boys. They go either to Cambridge, where the burden, especially as regards matriculation, is much lighter, or to one of the newer universities. In intention Oxford is possibly right. The product of a modern education is often wofully illiterate. He has the credit of knowing an extensive range of facts, and of having clear ideas about a large number of phenomena ; but he is often incapable of stating his facts in plain English, and is so deficient in expression and in the power of arrangement, that clearness is the very last epithet which can be applied to his expositions on paper. His orthography and grammar are too often villainous. This sort Oxford has determined to have nothing to do with, and no true friend of science would wish to shake the determination. It may be doubted, however, whether the particular means of exclusion which are adopted, viz. insistence on a knowledge of Greek accidence, are altogether appropriate. It is quite possible for a man to have plenty of miscellaneous information, a good literary style, and originality of thought, without knowing as much of the Greek irregular verbs as would enable him to pass the ordinary college matriculation examination or responsions. The fact is tacitly admitted ; for, with a strange inconsistency, the same section of the University which shudders at the idea of abolishing the Greek test for men, has lately opposed the admission of women to the B.A. degree for this reason, amongst others : that it would involve their having to go through the same Greek course as men, instead of being exempt from it as at present. But if it is asked why Greek is essential to the culture of men and unessential to the culture of women, no answer is vouchsafed.

The amount of Greek required for responsions is only acquired by some—probably by the majority—of boys at the cost of an amount of time utterly disproportionate to the results obtained. For in the end, though they may scrape through examinations, they really know no Greek worth mentioning, and what little knowledge of it they may have acquired is so fugitive that in a year or two after the examination they could not conjugate a Greek verb, and would be lost if they attempted to construe the easiest passages from Xenophon. It is idle to say that this modicum of fugitive knowledge is essential to culture. The Greek test is in a great number of instances a complete failure, and the imposition of it serves only to prevent many boys from attaining to culture by means suited to their natural aptitudes.

It is largely due to Greek that the numbers of the science school at Oxford are kept in check. If the University seriously wished the school well, it would allow elementary science, together with a modern language, to be offered as an alternative to Greek in responsions, and colleges would follow suit in their entrance examinations. Were this done, a large number of boys, freed from the trammels of a study which is repellent to them, would be able to learn enough of science to qualify for a science scholarship, and would in addition be able to acquire a knowledge of English and French or German literature sufficient to entitle them to the designation of scholar in the widest sense of the term.

To turn to the question of fellowships. They may be regarded as possible encouragements to science in two ways—prospective and actual. No doubt the prospect of obtaining one out of a considerable number of fellowships in any given subject will attract clever undergraduates to that subject. The actual holder of a fellowship may be supposed to exercise considerable influence in his college in favour of the subject which he professes. Nearly all the science professorships are attached to fellowships in one college or other, and in addition there are thirteen scientific Fellows receiving emolument in various colleges. Therefore it would appear that, in point of influence in college counsels, Oxford is not so very badly off. But the outside world is apt to over-estimate the influence which a Professor-Fellow or an ordinary Fellow exercises in educational matters, unless indeed he be a man of exceptional force of character. Educational questions rarely come before a full college meeting. The control of studies in each college is vested in the few Fellows who are tutors, whose function it is to exercise a general supervision over the moral and intellectual well-being of undergraduates. This supervision has been formed into a system of which it is not too much to say that it is in the highest degree inimical to science. It is quite unlike the system which exists under the same name at Cambridge, and exercises a much greater pressure on undergraduates.

Every freshman on arrival is assigned to a tutor, whose business it is to set him on a course of study, to see that he goes to the proper lectures, that he is punctual in his attendance at them, and attentive to his reading. A tutor may or may not, as the case may be, undertake also the private instruction of his own pupils. Since there are many avenues to the art's degree, it might be supposed that the tutor would point out to each freshman the various courses of study open to him, would give him the choice of any one of them, and the necessary information as to the proper mode of following up his choice when made. Were this done, there is reason to believe that a much larger proportion would select natural science. But the freshman is not invited to make a selection. Scholars, whether classical, mathematical, or scientific, are sent at once to their respective subjects. A commoner, if of more than average ability, is told that he must read for honours in classical moderations, and afterwards for "greats" ; if of average capacity, then law or history is indicated ; if of lesser ability, the prescription is pass moderations with two pass classical schools, and probably political economy for the third. Neither honour men nor pass men hear of science unless they make particular inquiries about it ; and if they do, they are as often as not told that it will not give them the breadth of education necessary for their future careers. Instances can be cited of freshmen anxious to read science having been ordered to take a classical school instead.

Obviously this state of things would not exist if science were adequately represented on the tutorial staffs of colleges. It is most inadequately represented. Christ Church is the only college which shows to advantage in this respect. By reason of special endowments, it maintains three science lecturers, known as Lee's Readers, and of these the two senior are also tutors. There is a science tutor at Keble. (It is interesting, by the way, to note that the two most distinctively religious foundations in Oxford are those which give the most substantial recognition to science : it has not been discovered that their religious character suffers thereby.) In no other college is there a science tutor. There are lecturers, but the powers of a lecturer are not those of a tutor, either in theory or in practice. In some cases, indeed, the individuality of the lecturer may give him an influence coequal with that of the tutors, as is the case at Balliol and Trinity, and elsewhere, as at Merton, New College, Magdalen, and St. John's some considerable freedom of action is conceded to science lecturers ; but in other cases, the duties of the lecturer are limited to the arrangement of the work of such men as the tutors may send to them. Speaking generally, it may be said that the tutors

propose and dispose the courses of study; lecturers carry their behests into effect. The initiative is in the hands of the tutors who, with few exceptions, are classical, some few being mathematical, and only three scientific. By excluding scientific men from tutorships the Oxford colleges keep science at arm's length.

Three causes, then, militate against the increase of the scientific school at Oxford: the absence of any test of scientific acquirements in responsions and in most college entrance examinations, the severity of the Greek test, and the exiguous number of science tutors in colleges. These causes might easily be removed, but Oxford does not remove them, and, as a whole, it is unwilling to do so. At the bottom of it there is the wish that it should remain in the present what it has been in the past—the home of classical studies and of metaphysical philosophy. There may be those who would maintain that a university has the right to determine what courses of study should be characteristic of it. But it may be urged that the function of a university is not to be exclusive. Should it not rather be its duty to recognise and bestow its approval on the intellectual movements which have done, and are doing, most for the advancement of mankind? He would be singularly blind to what is going on around him who would deny that natural philosophy has been the great intellectual movement of this century, and that its methods and conclusions have been forced, willy-nilly, on every form of study that exists. But blindness seems to be prevalent among the majority at Oxford, or if not blindness, then wilful obstinacy. For its graduates, in their capacity as members of the University, have been obliged to give public sanction to science, and to spend large sums of money in making provision for teaching it. But in their more private capacities, as Fellows of Colleges, they stultify themselves by stopping the stream at its fountain-head. The endowments of colleges were given for the advancement of religion and sound learning. In times gone by sound learning meant Greek, and why? Because Greek literature contained not only all the metaphysical, but also all the natural philosophy known to the world. It is long since Artistotle has ceased to be the authority in natural, that he still is in metaphysical, science. But in the course of change the authorities have clung to Aristotle, and the endowments which originally were devoted to all sections of his work are now confined to only a part of them. The schoolmen, Duus Scotus amongst them, argued with as much subtlety about the scientific as about the logical teachings of Aristotle, and in so far imitated the spirit as well as the letter of the Greeks. Nowadays the letter remains, but the spirit is lost to the classicists, and has gone over, deprived of its material endowments, to science. How much longer will Oxford cling to the belief that it is the language in which they wrote, rather than the spirit in which they worked, which made the Greek philosophers the fathers of thought? It is indeed a curious satire on a modern classical education that the very things in which the Greeks were most interested are those which the Greek student of to-day most disparages.

It is to be hoped that Oxford will become awake to the unreasonable attitude which it has adopted towards natural science, unreasonable alike from the point of view of modern requirements and of the purposes of the philosophers whom it professes to venerate. For its own sake it is to be hoped that the awakening will come from within; if it does not, it will assuredly come from without. The University has just had a reminder of the dissatisfaction which was felt with the place assigned to science in its local examinations, and it has made haste to repair the defect. The dissatisfaction with its external examinations is as nothing compared with the growing dissatisfaction with its internal system, which, if left unremedied, must prejudice its reputation and destroy the influence which it possesses in the intellectual world.

Let it be said, in conclusion, that there are many at Oxford who are classical to the core, yet would willingly do all that is required for the advancement of natural science. They are mostly to be found among the middle-aged, not among the younger graduates. If certain actions of classical Oxford have been condemned in what precedes, exception is of course made of the more liberal minority, whose actions, if left unfettered, would be all that the most bigoted man of science could desire.

NOTES.

WE are informed that notification of the following additional delegates to the International Conference on the Catalogue of Science has now been received at the Royal Society:—Austria: Prof. Ernst Mach, Prof. Edmund Weiss. Germany: Prof. Walther Dyck (Munich), Prof. Van 't Hoff (Berlin), Prof. Möbius (Berlin), Prof. Schwalbe (Berlin), Oberbibliothekar Wilmanns (Berlin). Norway: Dr. Jorgen Brunchorst. The list of delegates is therefore now a remarkably complete and full one.

SIR GEORGE BADEN-POWELL has completed his arrangements for taking an observing party to Novaya Zemlya to observe the forthcoming solar eclipse. He will be accompanied by Dr. Stone, of the Radcliffe Observatory, Oxford, and Mr. Shackleton, of the Solar Physics Observatory, South Kensington.

AMONG the Civil List pensions shown in a return just laid upon the table of the House of Commons, we notice a pension of £200 to Mrs. Huxley, one of £120 to Mr. James Hammond, and one of £120 to Mr. Oliver Heaviside.

PROF. VAN DE SANDE BAKHUYZEN, Professor of Astronomy in the University of Leiden, has been elected a Correspondant of the Section d'Astronomie of the Paris Academy of Sciences.

DR. SAMUEL WILKS, F.R.S,, President of the Royal College of Physicians, has been appointed one of her Majesty's Physicians Extraordinary, in the place of the late Sir George Johnson.

THE death is announced of Prof. A. G. Stoletow, Professor of Physics in the University of Moscow. Prof. Stoletow was the author of several important memoirs on magnetism and electiicity, the velocity of sound, the critical state, and other physical subjects.

SIR JOHN PENDER, who was for many years prominently associated with the promotion of submarine telegraphy, died on Monday. It was largely due to his enterprise and faith in the practicability of laying a submarine wire between England and America, that the capital required to lay the Atlantic cable of 1866 was subscribed. He also took a leading part in the organisation and development of the Mediterranean, Eastern (India and China), Australian, South African, and Direct African cables. It is stated that the cable mileage of the submarine telegraph companies over which he presided at the time of his death amounts to 73,460 nautical miles.

NOTHING is safe from syndicates of speculators. From a question asked in the House of Commons on Tuesday, it appears that an attempt is being made to exclude the public from right of way to the Giants' Causeway. Unfortunately that great natural wonder is not public property, and cannot, therefore, be protected from the syndicate which proposes to interfere with the right of access to it.

THE distribution of prizes to the students of the Charing Cross Hospital Medical School will take place next Tuesday,

July 14. The Hon. Mr. Justice Vaughan Williams will occupy the chair.

The geological collection at Peel Park, Salford, which some years ago was withdrawn from public view, has been entirely rearranged, and was reopened last week. The process of re-arrangement has been carried out by Mr. Herbert Bolton, of the Manchester Museum. The collection is now in a condition which will make it of service to students, and it will doubtless become an important factor in the educational progress of the borough.

A telegram from Sir Walter Sendall, High Commissioner for Cyprus, reports that incessant earthquake shocks have been felt there for several weeks, causing great alarm and interruption of business. A Reuter telegram from Larnaca, dated July 6, says: "Violent shocks of earthquake continue to be felt in the island. A general panic prevails at Limasol, and the Government and military authorities are providing tents for the people. Permission has also been given to families to take up their quarters in the commissariat huts and camp at Polymedia. The town is deserted, and the Government offices, the bank, and the telegraph office have been installed under canvas."

Mr. John Milne writes us, that between June 23 and 31 he recorded several earth disturbances, which from their character had apparently originated at great distances. One commencing at 9h. 2m. 35s. G.M.T., on June 29, is probably identical with the earthquakes which on that evening shook Cyprus. With regard to the records of Prof. Vicentini of Padua, which in Japan mean time occurred at about 8.30 p.m. on June 15, and 5 and 9 a.m. on the following morning, he remarks that he only recorded the former of these on the 16th—his instrument being dismantled for adjustments to correspond with those of a second instrument which that day was installed at Carisbrooke Castle. Certain telegrams tell us that the sea waves on the coast of Japan took place on June 17; but this information, which, it will be observed, does not accord with what was noted in Europe, has not yet been confirmed.

The highly poisonous nature of acetylene has suggested to M. Chuard the possibility of employing carbide of calcium as an insecticide for agricultural purposes. M. Chuard proposes to try thoroughly mixing the carbide with earth, so that under the influence of moisture acetylene would be slowly given off at the roots of plants, thus preserving them from attack. At the same time, the bye-products, consisting of chalk and a little ammonia, would have a beneficial effect on the soil. It is proposed to try this method against phylloxera. Whether this would succeed equally well in all weathers, wet or dry, is quite another question.

In the *Annales de micrographie*, M. Miquel gives statistics for ten years of the numbers of bacteria in a cubic metre of air, both in the centre of Paris and in the park of Montsouris. In consequence of local improvements, the air in the park has gradually become purer, the number of bacteria having decreased from 480 per cubic metre in 1884 to 275 in 1893; but the air in Paris itself has increased in micro-organisms from 3480 in 1884 to 6040 in 1893. This large increase M. Miquel attributes to the greater cleanliness of the inhabitants, who, by dusting out and cleaning their houses and shaking carpets, &c., stir a large quantity of germs into the air. He even goes so far as to condemn this form of cleanliness on the ground that the germs are simply blown about by the wind, and find their way into the houses again, so that if you do not get your own germs back, those from your neighbours fly in at the window instead.

It is nearly ten years ago that Dr. Carl Auer von Welsbach first enunciated the property of rare earths, which led to his discovery of the incandescent light. In a contribution to the *Atti della R. Accademia dei Lincei*, Signor Enrico Clerici now considers the action which takes place when vegetable tissues are soaked with solutions of certain salts, such as are used in the preparation of incandescent mantles, and the organic matter is afterwards removed by calcination. It appears that if sections of wood are treated in this manner with nitrates of certain metals, and the ashes are examined under the microscope, every detail of the original tissues is found perfectly preserved, even down, for example, to the scalariform ducts of *Pteris aquilina*. The author compares this process with the petrifaction of fossil woods, and he concludes that we have here a phenomenon of molecular interposition with which it is possible to cause certain insoluble and refractory oxides to penetrate into cell-walls and vegetable fibres, and to transform them in the course of a few minutes into true petrifactions.

The anxiety of German municipal authorities to attract men of science to their cities and retain them there, is exemplified by a note in the current number of the *Lancet*. It may be remembered that in 1890, when Prof. Koch made his announcement respecting tuberculin, a special institution was founded by Parliament, under the name of the Royal Institution for Infectious Diseases, in order that he might be enabled to continue his researches on the treatment of such diseases on a larger scale than before, and it was placed entirely at his disposal instead of being controlled by the university, like all the other scientific institutions. It was, in fact, a special hospital in which new methods of treatment were to be tested, and it also contained a large laboratory, provided with every requisite, where not only Prof. Koch and his staff, but a number of other medical men carried on scientific work. The Government having lately announced that the Institution would possibly be removed from Berlin, the town council of Frankfurt offered to provide Prof. Koch with ample laboratory and hospital accommodation if he would agree to settle in their city. But when these negotiations became known, the medical as well as the lay press urged the Government to take measures to retain this important establishment in the metropolis, and an arrangement has now been made according to which the Institution is to be attached to the new Berlin Municipal Hospital at present in course of construction. The laboratory department will be built and furnished by the State, whilst the wards for infectious diseases belonging to the hospital are to be placed at the disposal of Prof. Koch by the municipal authority. This arrangement was strongly supported by Prof. Virchow, who is a town councillor, and it will, says our contemporary, undoubtedly have the approval of the medical men of Berlin, anxious as they are not to lose so celebrated an investigator as Prof. Koch. The spectacle of the London County Council holding out advantages to a man of science in order to dissuade him from migrating to another city awaiting to receive him with acclamation, is one which we are unable to imagine.

Last autumn a mysterious disease appeared amongst the poultry-yards in Rome, and was of so virulent a type that it produced a mortality of about 60 per cent. amongst the fowls which it attacked. Careful investigations could not identify it with the fowl-cholera of Perroncito and Pasteur, or with the cholera of ducks described by Cornil, or indeed with any other of the diseases hitherto bacteriologically associated with feathered animals. Dr. Salverio Santori, of the Laboratorio medico-micrografico del Comune di Roma, has recently published in an Italian hygienic journal the investigations which he has carried out as to the nature and origin of this epidemic. His results are extremely interesting, for he has succeeded in isolating,

not only a new pathogenic micro-organism, but one which belongs to the class of pigment-producing bacteria, the latter being but rarely associated with disease. In consequence of the splendid red colour it elaborates in artificial culture media, he has called it *Eritro-batterio*. In its microscopic appearance, and indeed in many other respects, it resembles the well-known *B. prodigiosus*, but it differs from the latter in its extreme virulence when subcutaneously inoculated in very small quantities into white rats, guinea-pigs, rabbits and fowls, death ensuing in from twelve to eighteen hours when liquefied gelatine-cultures are employed. When introduced *per os*, death is postponed for sometimes two months; but during the last ten or twenty days of the animal's existence, its extremities are completely paralysed. In both cases the microbe is found in the blood and all the organs of the body, but more especially in the fluids of the peritoneal cavity. It fails to elaborate its pigment in the absence of air, or when exposed to a temperature of 37·5° C., although it grows abundantly, and its virulence is not in the least diminished. Its pathogenic properties rapidly disappear in artificial cultures, often after a week; and the best method of preserving its virulence was found to be soaking silk threads in cultures, and letting them dry. Under these conditions, its virulence was preserved for three or four months. No immunity was induced in animals by administering gradually increasing doses of the toxine elaborated by it in broth. When exposed to the direct rays of the sun, in drops of broth enclosed in a Petri dish, it was destroyed in from eleven to thirteen hours.

"LEFT-HANDEDNESS in North American Aboriginal Art" is the subject of a short essay, by Dr. D. G. Brinton, in the May number of *The American Anthropologist*. He finds that a preference for the right hand and side has existed in the majority of mankind from earliest times, though not always in the same degree, and concludes that the ultimate reason for it is to be found in the erect posture of man. "The Anthropoids and other primates closest to men are ambidextrous, displaying no preference for either hand. But the erect posture introduces a new distribution of force in the economy; it opposes the powerful retardation of gravity to the distribution of the arterial blood above the level of the heart. The great arteries arising from the aorta carry the blood in an appreciably shorter course, and in less time, to the left brain than to the right. Its nutrition, therefore, is the more abundant, and its vitality the more active of the two hemispheres. Hence the right side of the body, which it controls, is more ready to respond to a stimulus on account of its higher innervation." There is also a short note on this subject, by O. T. Mason, in the June number of the same journal.

PROF. FRANK N. CUSHING'S expedition to explore the neighbourhood of Pine Island, of which mention was made in NATURE several months ago, proved extremely successful. Prof. Cushing has just returned laden with rare and interesting archæological specimens, and bringing the story of discoveries which demonstrate the existence of a prehistoric people in South-western Florida and the neighbourhood, who have left a multitude of mounds and other structures of couch shells, and whose works seem to furnish the key to much that was inexplicable in American archæology. He says that this ancient people differed in many ways from any others hitherto known; but that they somewhat resembled the Swiss lake-dwellers in their mode of life, and that their state of culture was quite similar and equal to that of the mound-builders and the Mayas and other builders of the ruined cities of Yucatan and Central America. Innumerable islands were found covered with shell foundations, and some with structures covering hundreds of acres, and rising fifty to sixty feet above the sea. A low mound, sixty feet in diameter, near Tarpon Springs, was thoroughly explored; more than six hundred skeletons were found, besides a large quantity of pottery, stone and other objects of art. At Marco, near the southern end of the Florida Peninsula, extraordinary painted tablets were found; also many carved wooden vessels, and implements and utensils of shell and bone. Sections of the shell islands made below the gulf level showed them to be entirely artificial, and the result of slow and long-continued building. The civilisation developed on these islands is supposed to have extended southward to Yucatan, and northward to the abode of the mound-builders. A notable collection of masks was found, put away in sets, each with an appropriate animal figure-head, designed foruse by priests performing the myth drama. The shell structures of the Ten Thousand Islands, as well as those on the mainland, are covered with peat and dense growths of mangrove, cactus and other tropical vegetation. The general plan is similar in all. There is a network of enclosures of various sizes, or ridges leading up to terraces crowned by gigantic mounds. A series of level-topped pyramids surround two or three lakes, from which channels lead out to the sea. The resemblance to the ancient cities of Yucatan is striking and instructive. The explorations made lead to the inference that the Ten Thousand Islands are nearly all artificial.

THE publication of the *Annals* of the Russian Central Physical Observatory for the year 1893 has enabled Dr. Hann to collate the mean temperature conditions of Verchoyansk, in Russian Siberia, from observations extending from nine to eleven years. The position of this place, which from the extraordinary lowness of the winter temperatures has become classical from a climatic point of view, is 67° 34′ N. lat. and 133° 51′ E. long. We extract the following remarkable records from the *Meteorologische Zeitschrift* for June. The figures refer to the lowest monthly means, and the absolute minima, respectively: November −47°·6, −72°·4; December −63°·0, −82°·8; January −71°·1, −90°·0; February −72°·0, −93°·6; March −43°·2, −77°·4. The extraordinary minimum for February has been quoted previously; it occurred in 1892, and is supposed to be the lowest reading recorded in any part of the globe. The mean yearly temperature, corrected for diurnal range, from values calculated by Dr. H. Wild, is 1°·0 F.

AT the meeting of the French Meteorological Society on the 2nd ult., M. Angot communicated a summary of five years' observations on the velocity of the wind at the top of the Eiffel Tower and at the Central Meteorological Office. These observations fully confirm results previously obtained, and show that the diurnal variation of the wind on the tower is quite different from that observed near the ground. The velocity is nearly constant during the night, slackens during the early morning, and reaches its minimum in the afternoon. Near the ground, on the contrary, it is known that it freshens soon after sunrise until early in the afternoon, and then decreases regularly during the night. These results show that this variation is only a phenomenon peculiar to the lowest strata of the atmosphere. It is interesting to note that it is only necessary to ascend about 1000 feet to meet with the conditions known to exist on mountains, viz. maximum and constant velocity during the night, and decrease of velocity during the day, under the influence of the vertical motion of the air due to the heating of the soil.

WE are glad to call attention to the publication of Part iv. (vol. iv.) of the *Transactions* of the Leicester Literary and Philosophical Society. Among the contents we notice: "Notes on the Swiss Flora," by Mr. G. C. Turner; "Note on a Dermoid Tumour from a Frog," by Mr. F. R. Rowley; and "A Comparison between the Lepidoptera of Japan and Great Britain," by Mr. W. J. Kaye.

FOUR new volumes have appeared in the Encyclopédie scientifique des Aide-Mémoire series. In one of these—"La Spectroscopie"—Prof. Julien Lefevre briefly describes the application of spectrum analysis to physics, chemistry, physiology, and astronomy. The different methods employed for the observation of emission and absorption spectra in the laboratory, the solar spectrum, and the constitution of radial movements of stars are described, and a chapter is devoted to phosphorescence and fluorescence. The study of prisms, spectroscopes, and the theoretical side of the subject is treated in a companion volume—"Spectrométrie-Appareils et Mesures"—in the same series. A third volume recently received is entitled "Attaque des Places," by Lieut.-Colonel E. Hennebert. In it the various methods of besieged and besiegers, in past and present times, are set forth for the instruction of military engineers. MM. H. Moissan and L. Ouvrard have contributed to the series a valuable little volume on nickel—"Le Nickel." They describe in succession the physical and chemical properties of nickel, the principal compounds, minerals containing nickel, the metallurgy of nickel, alloys, extraction of nickel by electrolysis, and the principal applications of the metal.

THE additions to the Zoological Society's Gardens during the past week include two White-tailed Deer (*Cariacus leucurus*, ♂ ♀) from Canada, presented by Mr. Richard R. Dobell; a Red-bellied Squirrel (*Sciurus variegata*) from Vera Cruz, presented by Mrs. G. Maria Pullen; a Blue-fronted Amazon (*Chrysotis æstiva*) from South America, presented by Mr. A. E. Corsbie; a Black-headed Gull (*Lorus ridibundus*), European, presented by Mr. James Boorne; a Peregrine Falcon (*Falco peregrinus*), caught off the coast of Terra del Fuego, presented by Mr. T. W. Hubble; two Spotted Salamanders (*Salamandra maculosa*), European, presented by Mr. Philip Gosse; a Chimpanzee (*Anthropopithecus troglodytes*), a Temminck's Pangolin (*Manis temminckii*) from West Africa, two Ostriches (*Struthio camelus*, ♂ ♀) from Africa, a Blood-breasted Pigeon (*Phlogœnas cruentata*) from the Philippine Islands, two Hamadryads (*Ophiophagus elaps*), two Indian Pythons (*Python molurus*) from India, three Naked-necked Iguanas (*Iguana delicatissima*) from Tropical America, a Great-billed Rhea (*Rhea macrorhyncha*) from Brazil, deposited; a Crested Pigeon (*Ocyphaps lophotes*) from Australia, purchased.

OUR ASTRONOMICAL COLUMN.

BROOKS'S PERIODIC COMET.—The following search ephemeris for this interesting comet is from a complete one in *Astr. Nach.*, 3361:—

1896.	App. R.A. h. m. s.	App. decl. ° ′ ″	Brightness.
July 11	22 37 59·13	18 8 51·3	1·06
15	39 0·64	18 9 52·8	1·14
19	39 35·58	18 12 28·2	1·22
23	39 43·58	18 16 28·1	1·31
27	39 24·50	18 21 40·9	1·40
31	22 38 38·45	−18 27 52·2	1·50

Following the above table, the comet should be looked for soon after midnight about 11° north of the 1st mag. star Fomalhaut, which is on the meridian about 3.30 a.m.

MAGNITUDES OF SOUTHERN STARS.—In vol. xxxiv. of the *Annals of the Astronomical Observatory of Harvard College*, a complete and graphic description is given of the expedition sent out from the observatory at Cambridge, Mass., to South America, in order to extend the work of the Harvard Photometry to the stars of the southern hemisphere. Mr. S. I. Bailey, assistant professor of astronomy at the College, was the observer chosen for this duty, and in the report gives an historical account of his journey southward, which began on February 2, 1889, his only companions being his wife and son. Guided partly by the information furnished by the inhabitants respecting the meteorological conditions of the country, he at last decided to erect a station in Peru, choosing a spot on the summit of a mountain 6600 feet above sea-level, about eight miles north of east from the Chosica station of the Oroya railway. The observations have all been taken with the meridian photometer used for the northern stars, described in vol. xxiv. of the *Annals*. The instrument has two objectives, each of 10·5 cm. aperture and 166 and 145 cm. focal length respectively. Magnifying powers of twenty-eight and twenty-four diameters were used in the measurements. The magnitudes have been obtained by comparing each star separately with σ Octantis, mag. 5·5, this being the brightest star in the neighbourhood of the south pole. The first series of observations were taken on May 24, 1889, and for several months after this the weather proved very favourable, the instrument being used on nearly every clear night. As the summer season of the southern hemisphere approached, clouds became more frequent, and at length almost every evening was cloudy. This being so, the instrument was dismounted, and the observers travelled further southwards, remounting the photometer at a mining village called Pampa Central, near Valparaiso. In March 1890, they returned to Chosica, and again mounted the instrument in its old position, but the weather not proving so suitable as in the previous year, they again removed in September, and set up the station at Arequipa. Thus the measures of the various stars have been made at four stations. Following this introductory description, comes the voluminous catalogue of the magnitudes of 7922 southern stars, arranged on the same plan as the Harvard Photometry for the northern hemisphere.

RUGBY OBSERVATORY.—From the report of the Temple Observatory, Rugby, we learn that double-star observations were continued during last year. These observations are in continuation of the series commenced by Messrs. Wilson and Seabroke in 1871, which now comprises about 5000 complete measures of distance and position angle. The measures have been regularly published. The working list of double stars, which forms part of the report, gives approximate positions and measures for purpose of identification, and will be very useful to other observers who are following the same line of research. The observatory was open on eighty-three nights for the instruction of members of the school.

HARVARD COLLEGE OBSERVATORY.—Prof. Pickering has made the issue of the fifteenth annual report the occasion for furnishing some interesting particulars as to the establishment of Harvard College Observatory, and stating the general policy of the management. One of the statutes states that "the objects of the observatory are to furnish accurate and systematic observations of the heavenly bodies for the advancement of astronomical science, to co-operate in geodetical and nautical surveys, in meteorological and magnetical investigations, to contribute to the improvement of tables useful in navigation, and, in general, to promote the progress of knowledge in astronomy and the kindred sciences." It is noteworthy that no reference is made in the statutes to teaching, and the observatory is therefore primarily an institution of research, although such teaching as does not interfere with the regular work has been undertaken. While precise measures of position have not been neglected, the policy has always been to specially study the physical properties of the stars and other heavenly bodies, since less attention is usually paid to such work than to meridian work in most observatories. Accordingly much attention is given to photography, photometry and spectroscopy. Details as to the manner in which the various instruments have been employed are also given. The revision of the stars in the Harvard Photometry has been completed and is ready for publication, and it is worth noting that as many as 322 stars were observed on one occasion in the space of six hours, roughly one a minute; 107 photographs of the spectrum of β Lyræ have been lent to Prof. Frost for investigation, and this has suggested the possibility of increasing the usefulness of all the photographs which have been taken. Prof. Pickering invites correspondence with astronomers who may desire to borrow any of the photographs, and suggests the investigation of positions, distribution and brightness of stars in clusters, distribution of light in spectra, peculiar spectra, eclipses of Jupiter's satellites, and lunar mountains.

BAKU AND ITS OIL INDUSTRY.

NO city on this side of the Atlantic can show a more marvellous growth, within a short period of time, than Baku upon the Caspian; and, even apart from its petroleum industry, its natural advantages are so great, that it seems specially designed for a brilliant future as the emporium of the whole trade between European Russia, her Central Asian provinces, and Persia. So quick has been its expansion that, but an insignificant village of 1400 inhabitants thirty years ago, it can now boast a population considerably over 100,000, which is increasing yearly by leaps and bounds.

This rapid growth is mainly due to two causes: first, its magnificent harbour, well protected from the north by the extended horn of the Apsheron peninsula, and from the east by the Serpent's Island, which forms an efficient and natural breakwater; and in the second place, its immediate proximity to the main area of naphtha supply, which already rivals that of America, and promises in no distant future to become the exclusive market for all Asia, and also for the greater part of Europe. The commencement of the modern oil industry of the Caucasus dates from 1823, when the brothers Doubinin started a small works in the neighbourhood of Mozdak, which, owing to want of capital, they were forced to close in 1850. These pioneers were followed in 1836 by the engineer Voskoboinoff, who established a distillery at the foot of the mud geysers of Bog-Boga; but this effort proved likewise unsuccessful, and no trace of it now exists. Later, in 1859, M. Kokareff founded the Baku Petroleum Company, with the view of extracting the oil from the naphtha-impregnated soil; but experiment having shown in 1871 that the crude oil could be obtained by boring, this first method was abandoned, the artesian boring becoming universal. and a firm foundation was laid for the industry and for those marvellous developments which threaten an economic revolution in the lighting and fuel supply of a considerable portion of the world.

The year 1865 marks an important advance, a M. Witte having in that year established a manufactory of ozokerite on the Sviatoia Gora (Holy Mountain), and it was his engineer, M. Weisser, who, in that same year, established the first refinery in the town of Baku itself. So rapidly did the industry develop, that by 1873 the town was in danger of becoming entirely absorbed by the distilleries that rose on every hand, whilst the black, dense, and acrid smoke from the naphtha-fed furnaces poisoned the atmosphere. Baku, however, being under the influence of a despotic government, M. Staroselsky, the then governor, was enabled to effect a revolution, which, however drastic it may appear to our circumscribed democratic conceptions, was radical and efficacious. This consisted in issuing an edict that the refineries situated in the town were to be removed outside its limits, and for that purpose the corporation ceded certain town properties situated at a distance of about two versts. This land they divided into a series of blocks of from 2000 to 2500 square sargenes each (sargene is seven square feet English), and suddenly, as if by magic, eighty new works sprang into existence, their erection going forward at fever heat day and night until completed.

How intolerable the nuisance had become may be inferred from the fact that the sole firing material in use for boilers and distilling-tuns being the refuse oil, or so called astatki, and no smoke-consuming apparatus at that time being employed, not only the buildings, but the whole surface of the ground became coated with a thick layer of soot, whilst the roads were almost impassable owing to pools and ponds of oil. No wonder, therefore, that it should have received the name of the Black Town, (Tchornoia Gorod) a name which still clings to it, although through the introduction of an apparatus, by means of which steam under pressure and air are proportionately mixed with the naphtha residue, the smoke is now virtually consumed. As a result of this invention, the factories erected under the new conditions beyond the limits of the corporation land, notably Nobel's Villa Petrolia, and Popoff's Gardens, are perfectly clean. and this district in consequence has received the name of the "White Town."

Owing to the number of valuable bye-products obtainable, the refining process is complicated in its character, although the appliances used are very simple in their construction. The crude oil, fed through lines of pipes from the main sources of supply at Balachani, is stored in large iron reservoirs, from which it is drawn off to be treated in gasometer-shaped retorts. These being heated by steam coils to about 140° C., the products, having a low boiling point, such as gasoline and benzine, are separated, and passing into separate chambers are condensed. A further heating to about 150° C. in like manner separates the low-grade petroleums, which have been largely used in adulteration, and are so dangerous to the consumer. The third distillation becomes the petroleum of commerce, after having been washed and cleaned under treatment with sulphuric acid and caustic soda. The residues of heavy oils are generally treated in a separate establishment, and from them are extracted various grades of dyes, vaseline, lubricating oils, &c.; the demand for the latter constantly increasing, owing to their excellent quality and cheapness. The ultimate refuse astatki is likewise sure to become a keen competitor with coal as a fuel, a ton of this liquid being the equivalent of from two and a half to three tons of coal. To what uses it can be applied is well exemplified in the town itself: until very recently it was used for watering the streets, and not only is its employment universal in every kind of manufacture, but also for all heating and other domestic purposes. Its use is also rapidly extending on the railways in South Russia. All the steamers on the Caspian and Volga, and the locomotives on the Transcaucasian and Transcaspian lines, burn no other fuel; and when we regard its portability and cleanliness, it would seem to be but a matter of time for its advantages to be generally recognised. Owing to the abundance of the supply, at times millions of gallons have been allowed to run into the sea, or have been deliberately set on fire, and it is no exaggeration to assert that a full half of these vast supplies from nature's storehouse have been lost and dissipated unproductively.

Baku is pre-eminently a centre of commerce, and for residential purposes most undesirable, it being subject to heavy dust-storms, rainlessness, intense heat, and almost entire absence of vegetation and fresh water. The only garden is the so-called Alexander II., maintained at great expense, the shrubs and trees being planted in soil brought from Persia. A few fresh-water wells give a very limited supply, the usual sources being brackish; but the railway company supplement it by cisterns filled from the river Koura, and almost every steamer imports some from the Volga. A peculiarity in the distribution of the local supply is, that the few fresh-water wells are in close proximity to those impregnated with salt.

Varied as are the subjects of study presented by the town itself, the chief centre of interest is undoubtedly the plateau of Balachani-Sabountchi, situated about eight miles to the north-east of Baku, and connected with it by a branch line of the Transcaucasian Railway. When viewed from a distance the tall truncated towers erected over the wells seem in such close proximity to each other, that they present the appearance of a pine forest; and it is only on a closer approach, that they prove to be the derricks containing the machinery necessary for boring or the pumping of the oil. These pyramids consist of a wooden-boarded framework, and are easily removable when the bore becomes exhausted. How thickly they are grouped, may be inferred from the fact that, within the limited area of three square miles, over 400 of them are crowded. (Fig. 1.)

Not the least puzzling of the many enigmas presented by these wells, is the nature of the source from whence the oil is drawn. Enclosed in its subterranean prison it needs, in many instances, but an insignificant outlet to rise as a roaring fountain of sand and oil to a height sometimes exceeding 200 feet, continuing in action for days and even weeks, spouting forth during the time many thousands of gallons per day; yet this in no way interfering with the supply from closely adjacent wells, which continue to yield their normal quantity.

It is therefore evident that the sources are independent of each other, and that although the reservoirs may have been originally arranged in regular series, yet, through the strata having become dislocated and faulted, they now form separate and distinct chambers of varying capacity and without direct connection between them.

Small though the evidence, geology throws some light upon the probable structure of the basin, whereas chemistry reveals but little as to the origin of the oil.

Geologically the town of Baku is situated on beds of Quaternary age, which have received the name of Aralo-Caspian beds; whereas the main portion of the Apsheron peninsula, on the south side of which Baku is situated, consists almost exclusively of Pliocene and Miocene strata, subdivided locally into the Baku, Apsheron, and Balachani formations. Wherever the

rocks, which consist mainly of limestones and sandstones, are exposed, it is evident from their highly inclined dips, varying rapidly from point to point, that the whole region has been subjected to great earth-movements, the presence of overthrust faulting having been specially noted by Dr. Sjögren, of Upsala. As a result of these movements, the strata have been thrown into a series of anticlinal and synclinal folds, upon whose upturned and denuded edges throughout the Balachani district beds of Aralo-Caspian age have been unconformably laid down, a most notable feature connected with them being the extreme thinness and the abundance of the layers composing them.

Chemically, numerous suggestions have been made as to the origin of the oil. Mendeléef ascribes it to the carbon enclosed in metallic iron, deep seated in the earth's crust. Daubrée and Coquand connect it with combined chemical and eruptive action; Fuchs and De Launay lay special stress upon its relation to disturbed districts, whereas Lesquereux ascribes it without reserve to the decomposition of vegetable remains, and Hofer regards it as being of animal origin. Seeing, therefore, that the geological and physical characteristics lend support to all the theories enunciated, to none of them can as yet be granted any other than a hypothetical value.

Since the introduction of boring in 1871, this system has been exclusively employed. The number of the bores in 1881 reached 375, and in 1886 490, of which, however, only 160 were in actual work, 180 having become exhausted, and 150 being plugged down as reserves. The enormous supply of the crude oil may

FIG. 1.—General view of the Balachani Oil-field.

be gathered from the following figures. In 1832 the yield was only 150,000 poods (pood = 36 lb.) = 2000 tons; in 1867, 999,999 poods, = 14,500 tons; in 1880, 300,000; and in 1890, 3,100,000 tons. That the supply is not inexhaustible, may be inferred from the fact that the depths of the bores are being progressively increased. We thus find that in 1871 the oil was reached at 70 feet, in 1873 this increased to 120 feet, in 1883 to 450 feet, in 1886 to 700; whilst a later bore, sunk to a depth of 1000 feet, has yielded no oil. It is evident, however, from the cellular character of the oil-bearing strata, and the immense supplies already obtained from a very limited area, that the period of exhaustion is indeterminable, and any conjecture baseless.

The means employed for raising the oil are of the simplest character; pumping, as understood in the ordinary acceptation of the term, is, owing to the depth of the bore, of course impracticable, so that after cessation of the flow consequent on the exhaustion of the gas, copper tubes called "jalonkas" are employed. These cylinders, about 12 feet long, are provided with a valve opening inwards on touching the bottom of the bore, and close on the tube being lifted filled with the oil. On reaching the surface the jalonka is lowered on to a platform, thus pressing in the valve and releasing the naphtha, which flows in a greenish-tinted stream to reservoirs connected by pipe-lines with the refineries in Baku.

It will be readily understood that in a district so saturated with naphtha oils, there must be an ever-present danger from the ignition of the exhalations of hydrocarbon gas, which escape not only from the bores, but through every fissure and cleft in the soil; and although every possible precaution is taken against such a catastrophe, many disastrous fires have occurred. Our illustration (Fig. 2) is from a photograph of one that took place in 1887, which was specially notable for its duration and devastation, all the derricks within a considerable area having been consumed, and all efforts to extinguish it failing until the volume of gas had become weakened and it burnt itself out.

These exhalations are most powerful in the district of Surachani, where the natural gas is made use of for lime-burning, for every domestic purpose, and as fuel for the boilers; in fact, it is only necessary to sink a pipe a few feet into the soil to obtain on ignition a flame of considerable length, and this is practically shown at the works of Messrs. Kokareff, where one such has been burning many years.

Adjoining this refinery, and placed by the Russian Government under that firm's special protection, is the ancient and celebrated temple of Zoroaster, which for over 2500 years was the sacred resort for pilgrimage of the Guebers, or fire-worshippers of Asia. (Fig. 3.) Formerly a flourishing monastery,

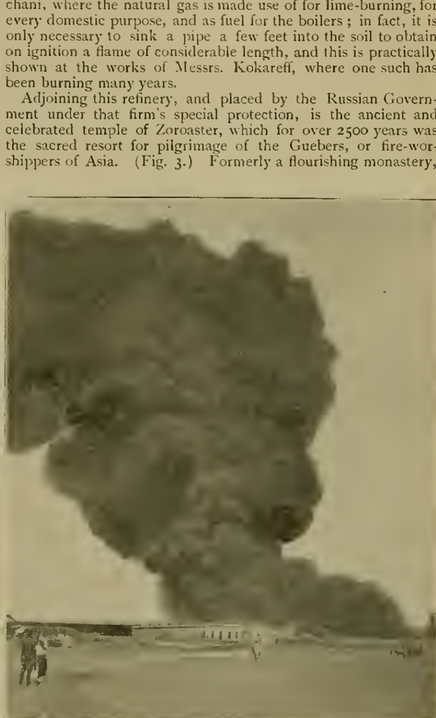


FIG. 2.—An Oil-well at Balachani on fire.

to-day it is but a decaying and deserted monument of the old religion of the Parsees. It consists of a large square courtyard enclosed by the cells of the monks, all opening inwards. A double-storied erection in the front was the dwelling-place of the chief priest, beneath which, and closely adjacent, was the chapel cell, on whose rude stone altars burned the Eternal Fires. In the centre of the courtyard is a square building, flanked with four towers, from which the flames ascended, and the arched recess in the basement was used as a crematorium wherein, by means of the sacred fires, the bodies of the faithful devotees were consumed. It is not only on land, however, that natural gas is abundant; a favourite excursion of the inhabitants and visitors being to take steamer on a calm dark night to the neighbourhood of the Baibat Point, where the gas rises through the waters of the Caspian sea in bubbling eddies, which, on being ignited with burning tow, covers the water with flames over a considerable area.

Although owing to its prominent position and natural advantages the attention of Europe has been mainly concentrated on the district and town of Baku, it must not be forgotten that this is but one out of many important petroleum fields awaiting

development in South-eastern Russia. Not only are there rich deposits known to exist in immediate proximity to the sea in the Transcaspian province, but an immense area of petroleum-producing strata extends from the Crimea to the Taman peninsula, and thence across the northern boundary of the Caucasian range to Petrovsk upon the Caspian, and many centres of production in these districts are now being opened up, which must shortly come into keen competition with the Baku industry. Already during many years oil has been extracted from borings in the Kouban district, whence by means of pipe-lines it is transported to a refinery at Novorossisk; but these will

FIG. 3.—The Temple of Zoroaster.

be insignificant when (should all the reports be confirmed) the wells at Groznaia and its neighbourhood are tapped, it being considered that they will rival, if they do not surpass, Baku in productiveness. It would appear that the beds are almost identical in age to those of the Balachani-Sabountchi areas, and it would be an interesting subject for future study to ascertain if the line of petroleum productiveness to the north of the Caucasus follows that of the depression which in a former period connected the waters of the Caspian with those of the Azoff, the Black Sea, and the Mediterranean.

The accompanying illustrations are reproduced from an excellent series in *Globus*. W. F. HUME.

A SEISMIC SURVEY OF THE WORLD.

THE principal object of a seismic survey of the world is to measure the velocity with which earthquake motion is propagated through its crust, and possibly through its interior, and from the resulting figures to give to astronomers and physicists additional data respecting its effective rigidity.

It is the converse of the answer to a problem which in 1889 was incidentally worked out by Lord Kelvin, who, assuming a certain rigidity for our earth, determined the rate at which vibrations were likely to be transmitted through the same, the object of the calculation being to compare the result with that obtained from observations on an earthquake which in that year, originating in Japan, had been noted at many stations n Europe. The feasibility of the proposed undertaking and the probability of its yielding satisfactory results are based upon the existence of observations of the following nature.

For many years past astronomers, and those in charge of self-recording magnetographs, have observed disturbances in their instruments at varying intervals after the occurrence of an earthquake in some remote locality. In 1867, about seven minutes after an earthquake in Malta, M. Wagner observed at Pulkova an oscillation of 3″ in a level. One hour and fourteen minutes after the great earthquake of Iquique on May 10, 1877 (effects due to which were observed by the writer in Japan), at the same observatory M. Nyren noted oscillations in the bulb of a level of 2″ which had periods of 20 seconds. The late Dr. E. von Rebeur-Paschwitz repeatedly observed and obtained records of earthquakes which had their origin at distances equal to or more than one quarter of the earth's circumference from his observing stations. Vicentini, Agamennone, and others provided with instruments sensible to slight movements of the earth's crust, have made similar records; whilst the writer has not only shared in contributing to this class of observations, but on one occasion at least has obtained satisfactory photograms of a disturbance originating at his antipodes.

The conclusion which may be taken as well established by these observations is that suitable apparatus placed in any part of the globe will record the movements due to severe earthquakes originating in any other portion of our globe, and therefore there is nothing unreasonable in saying that every observatory throughout the world, if it were equipped with proper instruments, would be in a position to contribute to the knowledge of changes which are continually taking place, not only beneath the land, but also beneath the ocean.

For a person or a community to imagine that they reside in a locality free from earthquakes, is one of the greatest of modern fallacies. Although movements may not be felt, all places are disturbed in a manner capable of being recorded very many times per year. In addition to earthquakes the focus of which may have been some thousands of miles distant, to the recording of which the present note is intended to draw special attention, unfelt disturbances of a local origin may be recorded. Even at places where shocks are unknown, excepting as rare events recorded in ancient history, these may sometimes average two a day. Other movements taking place beneath our feet are slow diurnal tiltings, annual variations in the vertical, tremors of probably two distinct characters, earth pulsations and elastic vibrations.

To designate all these movements, which vary in their periods between the fraction of a second and twelve months, as "earth tremors," and an instrument to record them, a seismograph or a tromometer, are evidently misnomers. Although a single instrument may be obtained which will give information about each of these movements, experience has shown that it is better to have a particular instrument for a particular purpose. To record rapidly recurring vibrations the most sensitive arrangement that is self-recording is, perhaps, a Perry tromometer, which will detect the disturbance produced by a moving train at the distance of a mile. To record slight changes of level in a district, such, for instance, as may accompany changes in barometric pressure, a bifilar or horizontal pendulum, which is nearly as insensible to elastic tremors as a Perry tromometer is to change of level, would be best.

What is wanted for a seismic survey of the world is an instrument that is sensible to the preliminary elastic tremors of an earthquake, and then to the slowly recurring quasi-elastic gravitational waves by which these are followed. For this purpose it appears that our choice rests between some form of ordinary pendulum apparatus, like that of Agamennone or Vicentini, or some form of horizontal pendulum. Whatever form is selected, each instrument must be similar and similarly adjusted. If this is not the case, then at each station different instruments may commence to move with different phases of motion, and the records for purposes of comparison are without value. For example, an earthquake may originate at a known locality, at a known time, and be recorded at twenty different observatories in Europe, at each of which good time is kept, but at each of which the recording instruments are different in character.

The result of the calculations based on these observations have shown, in one instance at least, that the velocities of propagation of motion from the origin to each of these stations have varied between 2 and 20 km. per second.

The cause of this apparent discrepancy lies in the fact, that at different stations, during a disturbance having a duration of perhaps several hours, the different instruments have commenced to move with different phases of motion. This is a source of error which has been thoroughly recognised by observers in Japan for the last twenty years, and by timing the rate at which a particular vibration has travelled between given stations, the apparently conflicting results to which we are otherwise led have been greatly reduced.

When an earthquake is observed at stations far distant from each other, it is no longer possible to identify a particular vibration at these stations; but what can be done, is to note the time at which the preliminary vibrations commence and the interval which follows before the undulatory motions appear. So far as observations have gone, the velocity of propagation of the latter movements varies between 2 and 3 km. per second, which is about the rate we should anticipate to be found for motion passing through the materials constituting the earth's crust. The velocity for the former, however, appears to vary between wide limits, 10 or 12 km. per second being about the average. Because this rate of transmission is greater than that at which motion could pass through glass or steel, the inference is that it may possibly pass *through* our earth, and because it is variable the idea suggested is, that the rate of transmission varies with

the depth of the wave path. Should this be so, the next suggestion is, that as a wave proceeds downwards refraction may take place, and that a focal concentration of energy may be found at the antipodes of a seismic centre.

From these remarks it is clear that amongst the most important work with which the seismologist has now before him, is to measure the speed at which the preliminary vibrations of an earthquake are transmitted, and because this is high, the definition on the recording surface must be clear, the rate at which this is moved must be such that time intervals may be measured to within 10 seconds, and the observing stations, if they are limited in number, should be widely separated.

In the choice of stations, at all of which there must be the means of keeping fairly accurate time, the plan originally suggested by the author was to choose these relatively to districts where large earthquakes are frequent. The districts selected were the South American coast, Japan, and the Philippines, Himalaya and Central Asia. By a system of trials it was found that fifteen stations could be chosen, nearly all of which happen to be in the United States or British colonies, about ten of which would form a series approximately 2000 miles and multiples of 2000 miles distant from any of the three districts.

With a series of this description, data of a fairly complete nature respecting the rate at which motion may be transmitted round and, possibly, through our earth at varying depth should be obtainable. Any addition to this series would naturally render our information more certain, and add to the value of records obtained from centres other than those specified.

The cost of installation at each observatory would be approximately £50.

The proposal here made is similar to one published by the writer in January 1895, and does not materially differ from the one put forward by that distinguished investigator, the late Dr. E. von Rebeur-Paschwitz, and now being so warmly advocated by Dr. G. Gerland of Strassburg (see pp. 135, 136).

J. M.

THE SPECIFIC GRAVITY OF THE WATERS OF THE SEA.

IN continuation of his paper on oceanic circulation, in the concluding volume of the *Challenger* Reports, which chiefly dealt with the distribution of temperature, Dr. Buchan has published in the *Transactions* of the Royal Society of Edinburgh a series of maps showing, so far as the present state of knowledge permits, the specific gravity of the waters of the great oceans at various depths; and accompanying the maps is an extended discussion of some of the points treated in the previous memoir.

In the paper just published, Dr. Buchan has departed from the mode of representing salinities and specific gravities employed in the *Challenger* Report, and instead of charting the actual values, gives the departures above and below an average assumed to be a mean for all the oceans. It is difficult to see that anything is gained by this method; and it has the undoubted disadvantage that any future change in the assumed means will involve the reconstruction of all the maps. Even at the surface there are considerable portions of the sea of which we can only guess at the mean temperature and salinity, and the general average given by Dr. Buchan may therefore undergo modification, notwithstanding the attempts to apply a process of integration. Below the surface, the general average is simply the mean of existing observations; and while an inspection of the map shows that these are by no means perfect, the fact that there is only a single line of observations in the North Pacific, one in the Southern Ocean, none in the Atlantic north of 40°, and none in the Indian Ocean, indicates that the general averages must be mere approximations. Another unsatisfactory effect of the adoption of this method is due to the fact that values above and below the general average are thrown into strong contrast by being printed in different colours on the maps, thereby frequently exaggerating their apparent difference. In the case of the North Pacific, for example, Dr. Buchan lays great stress on the low specific gravity of the waters of this ocean at all depths. Undoubtedly the observations show that they are lighter than the Atlantic by a quantity amounting below the surface to about 0·0008; but the fact remains that a change of, say, ·0003 in the mean for the globe at 300 fathoms would throw the whole of the North Pacific *above* the average, while the observations within that area themselves show inconsistencies amounting to double that quantity. We draw special attention to this point, because it seems to lie at the root of a certain weakness in the line of argument taken up by Dr. Buchan, leading to a confusion of what we may call the statical and dynamical problems of ocean circulation, somewhat analogous to that involved in Ferrel's theory of cyclones. In drawing up any general scheme of the movements of oceanic waters, it is necessary to keep clearly in mind certain "conditions of continuity"; if the surface salinity is anywhere reduced by copious rainfall, it must somewhere else be correspondingly increased by evaporation; if reduced by melting of field ice, a corresponding quantity of salt must have been added to the deeper waters where the ice was formed; if up-welling is produced by an off-shore wind, the same force must be competent to cause a down-draught somewhere else. These considerations seem to suggest several simplifications in the scheme of circulation proposed by Dr. Buchan.

Comparing the Atlantic and Pacific Oceans, we find in the former a limited area subject to atmospheric systems of considerable intensity, the air over a considerable proportion of the surface being relatively dry. Over the Atlantic there is accordingly a relatively great amount of evaporation, producing high surface salinity, and the water carried off is distributed over an area nearly four times as large as in the case of the Pacific, allowing of its gradual return. In the Pacific, on the other hand, the winds are not so strong, the rate of evaporation is slower, and the redistribution of the moisture more local. It may therefore be possible to account for a considerable part of the low salinity of the Pacific without assuming that the high rainfall of the East Indian region produces effects so markedly in excess of those due to the immense discharges of fresh water into the Atlantic or the Indian Ocean. Dr. Schott's observations in East Indian waters support this view, indicating that the great freshening due to heavy rainfall is here, as elsewhere, largely restricted to the immediate neighbourhood of the land.

As an example of the converse of the foregoing, we may take the case of the undercurrent flowing from the Mediterranean to the Atlantic through the Straits of Gibraltar. From the observations of temperature and salinity Dr. Buchan regards it as placed "beyond dispute" that the warming effect of this outflowing water "becomes strikingly apparent at about 500 fathoms," and "beyond this depth its influence is felt over nearly the whole breadth of the Atlantic to at least about 1000 fathoms." Now at the Straits of Gibraltar the depth is something under 200 fathoms, and the extreme width at the surface a little greater than the Straits of Dover; and it is known that the loss by evaporation from the surface of the Mediterranean is not nearly compensated for by the fresh water additions from the rainfall and the rivers which empty themselves into its basin. The amount of water issuing into the Atlantic must therefore be greatly less than the amount entering the Mediterranean, and a comparison of the volumes and temperatures of the two bodies of water shows that it is almost impossible to give the outflow from the Mediterranean credit for such widespread action.

The two cases we have quoted, perhaps the strongest of several suggested by Dr. Buchan's papers, seem to support the results of a number of recent investigations, indicating that the effect of differences of specific gravity, while by no means a negligible quantity, is in general small compared to the dynamical effects due to the momentum of the surface currents, even at great depths.

From this point of view, we at once obtain help from the researches of Pettersson and Krümmel, noting specially their results as to the tendency of surface currents to induce *reaction* currents under them, and to divide on changing direction, and bearing in mind the deflecting influence of the earth's rotation at all depths. In the Atlantic, the water driven northward along the American coast is blocked by the land, and is partly drained off by the easterly drift currents, partly sent downwards in a column separated into two parts, at least in certain seasons, by a bulging out of the cold Labrador current. Crossing towards the west coast of Europe, the easterly drift divides, a part escaping northward under regulation of the polar streams from the east of Greenland and Iceland, and a part banking up against the French and Spanish coasts and the north-west of Africa, as is shown by the "bottle charts" of the Prince of Monaco and M. Hautreux. The shape of the coast prevents all the water escaping laterally, and a part descends, carrying with it the efflux from the Mediterranean.

In the Pacific the effect is similar, subject to the difference that while the circulation is less energetic, it is also less inter-

fered with by the configuration of the land, and except off the coast of Central America, where the south-easterly drift is again "cornered," the effect of the earth's rotation becomes more apparent. The difference due to the Pacific being closed at its northern extremity is extremely striking.

H. N. DICKSON.

THE UNIVERSITY OF LONDON.

ON Monday the Duke of Devonshire introduced a Bill in the House of Lords to make further provision with respect to the University of London. In the course of a brief statement as to the circumstances which have led to the introduction of the Bill· the Duke of Devonshire explained that the Cowper Com, mission reported two years ago in favour of London University being made a teaching as well as an examining University, and recommended the appointment of a Statutory Commission to carry out the details of the scheme. It will be remembered that a Bill dealing with the question was introduced by Lord Playfair in the last Session of the late Parliament, but it was not proceeded with in consequence of the dissolution. His Lordship is reported by the *Times* to have said: "I believe that neither University College nor King's College is altogether satisfied with the scheme as sketched out in the Commissioners' report. But still more formidable opposition has manifested itself, not on the part of Convocation of London University as formally constituted, but on the part of a considerable body of members of Convocation residing for the most part in the provinces. This opposition, I believe, proceeds from an apprehension that under the proposed constitution of the University the teachers of the affiliated institutions and colleges will exercise a large and perhaps undue influence over the examinations of the University, and that students who have prosecuted their studies in independent colleges or privately will in future be placed at some disadvantage. The apprehension is that either the high standard which, it is admitted, has always been maintained by the London University will be lowered, or else that in the examinations arranged by the new body external students will compete on unfair terms as compared with students in the recognised teaching institutions. To meet objections of this kind we give in this Bill a somewhat wider discretion and larger powers to the proposed Statutory Commission than were proposed to be given in the Bill presented by Lord Playfair last year. While the Commissioners will be directed, as in the Bill of last year, to proceed upon the proposals of the late Royal Commission, they will also be directed to inquire into and have regard to the requirements of both the internal and external students. I trust that an opportunity will be afforded, by presenting this measure in a definite shape, to those who are concerned of ascertaining the real character of any opposition which may be offered to the proposed change in the constitution of the London University. Personally I am insensible to the motives which have actuated some graduates in offering considerable opposition to those proposals. After all it is the Senate of the London University which is charged with the duty, and on which rests the responsibility of watching over the interests and upholding the character of the University, and this Bill and the proposals of the Commission which it seeks to carry into effect have, I am assured, the warm approval of a large majority of the Senate of the University of London. This is a measure which practically has been recommended by two Royal Commissions, each of which was composed of men highly competent to pronounce an opinion on such a question as this. It is, I believe, supported by a very large majority of the most eminent scientific and educational authorities in the country, and it is, in my opinion, a very great anomaly, almost approaching to a scandal, that the great City of London should alone of all the great cities in the United Kingdom—and I believe I may add alone among the great cities of Europe—have remained up to this time without a teaching University. The experience during the last ten years of abortive attempts—which I have briefly recounted to your lordships—shows that almost insuperable difficulties exist to the establishment of any such teaching University in any other way than that which has been proposed by the late Royal Commission. It has been almost conclusively proved that the intervention of Parliament through the appointment of a Statutory Commission is necessary, and is the only means by which this desirable end can be effected." The Bill was then read a first time.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE French Senate has adopted the Bill for the establishment of district universities.

THE archæological library of the Ashmolean Museum at Oxford was struck by lightning during a severe storm on Tuesday, and the roof was set on fire, but fortunately the valuable books in the library were not damaged.

DR. J. NORMAN COLLIE, F.R.S., Assistant Professor of Chemistry at University College, London, has been appointed Professor of Chemistry in the Pharmaceutical Society's School of Pharmacy.

IN answer to a question put by Colonel Lockwood in the House of Commons, the Vice-President of the Council said, some nights ago, that the Teachers' Registration Bill could, as far as he could see, only be proceeded with this session if it were made entirely non-contentious.

LORD CROSS, Master of the Worshipful Company of Clothworkers, on Friday will lay the foundation-stone of a research laboratory in connection with the dyeing department of the Yorkshire College, Leeds. The expense of the new buildings, £15,000, is being borne by the Clothworkers' Company.

THE arrangements for the transfer of the right of patronage to the chair of Natural History in the University of Edinburgh, now exercised by the Crown, to the curators of patronage in the University, and the transfer of the right of patronage to the chair of Botany, now vested in the curators to the Crown, have been incorporated in a Bill, and the Bill has been introduced into the House of Lords by the Government.

AT the annual summer meeting of the Incorporated Association of Head Masters, which was opened on Friday last at Leicester, it was moved: "That to ensure the proper organisation of secondary education it is essential that, with the exception of non-local schools, every school or department of a school providing secondary education should be placed under a county authority administering secondary education." It was further agreed that the "local authority for secondary education should in no case administer a smaller area than that of an administrative county as defined by the Local Government Board."

REFERRING to the cost of education in Switzerland, Her Majesty's Secretary of Legation at Berne points out that it is much less than in England. In 1893 there were 8390 primary schools in Switzerland, with 469,800 children, and an average of 50 pupils per teacher, of whom there were 6290 masters and 3180 mistresses. The expenses of the cantons were, on an average, 50 francs (£2) per pupil, or 8 francs (6*s.* 8*d.*) per inhabitant. In the Polytechnic School of Zürich, to which the Federal Government makes an annual grant of £36,800, there are 720 pupils, of whom 309 are foreigners. Instruction is given in architecture, civil engineering, mechanics, chemistry, forestry, and training of teachers. The fees are about £8 10*s.* per pupil. There are commercial schools in six cantons, where the average expense to the pupil is £18 10*s.* per head. There are seven universities, with a total of 3742 male and 491 female students in theology, law, medicine, &c., among whom are many foreigners. There are, moreover, technical schools of all sorts for instruction in farming, dairy work, vine culture, &c., established throughout the country. In 1893, in the twenty-five cantons of the confederation, the expenses on account of education were, by the State, £660,200, and by the communes £839,960, making a total of £1,500,160, or an average of about 10*s.* per inhabitant. Under the heading of technical instruction £1,575,000 was spent in 1894.

THE Committee of Council on Education have decided to modify the existing rules for grants for instruction in science and in art, contained in the Science and Art Directory and the Minute of August 21, 1895, as follows, except as regards organised science schools and training colleges, to which these alterations do not apply:—In place of payments on the results of examination an attendance grant, except as stated below, will be made, on the certificate of the Committee of the

school, for each attendance of *at least* an hour's duration on the part of a student who has given not less than ten such attendances during the session. The minimum grant specified will be allowed if the inspector of the department reports that the teaching and equipment of the school are satisfactory, and that the class or classes are not too large for instruction by the staff of teachers. But these grants may be increased in any subject for efficiency up to the maximum specified; the efficiency being determined by the inspector's report and the success of the class in that subject at the May examination. The grants for science will be :—2*d.* to 6*d.* for each attendance in a night science class in the elementary stage, and 4*d.* to 1*s.* 4*d.* in the advanced stage; and for each attendance of 1½ hours' duration given to practical work in chemistry, physics, metallurgy, or biology, in a properly equipped laboratory, 3*d.* to 9*d.* in the elementary stage, and 6*d.* to 1*s.* 4*d.* in the advanced stage. The payments for attendance in a day science class will be at half the above rates. No student may be registered in the advanced stage of any subject until he has passed the examination of the department in the elementary stage, or has passed some corresponding examination which is considered by the department to sufficiently meet the requirements of the case. No student may be registered for more than two years for attendances in either the elementary or the advanced stage of any one subject. The grants will only be made if the student is of the industrial class as defined by the Science and Art Directory, and if the attendances for which the grant is claimed are such as can be legitimately registered under the rules. Grants for honours in the science subjects of the Department of Science and Art will continue on the same scale as at present.

An excellent survey of the systems of technical education in Austria, Germany, France, and Switzerland, compared with what is done in England and Ireland, is contained in a pamphlet entitled "Technical Education: a National Necessity, its Uses and Advantages," by Prof. Henry Corby, published by J. Mahony, Cork. Prof. Corby shows what technical education has accomplished on the continent, and points to the comparative neglect of it in England, the result being a loss of commercial supremacy. As to Ireland, technical education is almost unknown there. There is only one technical school of note, and that has been established within the past few years in Dublin. In Cork something has been done; but it is disjointed and fragmentary. However, it tends in the right direction, and we hope with Prof. Corby that it may yet prove to be the mosaic pavement on which will be raised a large and comprehensive technical school, which will be worthy of the commercial enterprise of the capital of the South of Ireland. It is suggested that good would come if Cork were raised to the dignity of a university city. Why not have a university for the South of Ireland in the capital of the South? At present, Prof. Corby points out, there are only two universities in Ireland, both located in Dublin, while Belgium, with a population almost exactly the same, has four universities; Scotland also has four, and in scientific Germany there are as many as thirty-one universities. To show what a thorough general and technical education can do for a country, it is only necessary to refer to Switzerland, which, though only about half the size of Ireland—and, as fully one-half of its soil is entirely unproductive, it may be regarded as only about one-fourth the size of Ireland—is able to maintain three million inhabitants, whilst the population of all Ireland is little more than four and a half millions. Prof. Corby describes what some continental nations have done for agriculture, and then he asks how can the smaller farmers of Ireland—many of them poor and half-educated—attempt to compete with such rivals? It has been urged that Ireland ought to have a Minister of Agriculture, but it is suggested that a Minister of General and Technical Education, who would give special attention to agriculture, would be better. If national teachers were trained at agricultural schools, and students were given practical instruction in agriculture, if chairs of Agriculture were established in all the higher colleges, and special lectures delivered in the auxiliary sciences, such as chemistry, zoology, botany, and mineralogy, then, thinks Prof. Corby, the hope might be entertained that the vast tracts of waste land in Ireland would be reclaimed, and a large scheme for reafforesting undertaken with every prospect of success. We trust that his admirable pamphlet will be the means of giving an impetus to the cause of technical education in Ireland.

SCIENTIFIC SERIALS.

The Reliquary and Illustrated Archæologist maintains its reputation for the beauty of its illustrations. In a late number (vol. ii. No. 2) an elegantly carved wooden Egyptian toilet-spoon of the eighteenth dynasty is reproduced in collotype.—The editor, J. Romilly Allen, has carefully studied the cup-and-ring sculptures of Ilkley in Yorkshire, and gives numerous illustrations of these still mysterious markings. All that we know about them is that they are religious symbols, and that they mostly belong to the Bronze Age, although cups only may possibly have been used at the end of the Neolithic period.—The much-discussed "Dwarfie Stone" of Hoy, Orkney, has been investigated by Mr. A. W. Johnston in a very thorough manner; he comes to the conclusion that it was originally a sepulchre with a stone door.

Internationales Archiv für Ethnographie (Heft 2, Bd. ix.)—The question of alleged native writing in Borneo is discussed by Mr. H. Ling Roth and Prof. H. Kern; inscriptions in one or two scripts are known, but there is no evidence that any form of writing was known to the Dyaks. Heer M. C. Schadee, in collaboration with Herr Schmeltz, has a communication on the ethnography of Western Borneo, which is illustrated in the characteristically excellent style of this journal. In the current number (Heft 3) Schmeltz continues his erudite notes on ethnographical objects from New Guinea. In a note entitled "Prudery in Scientific Matters," the same author states, on the authority of Prof. Brigham of Honolulu, that "the Government of New Zealand has not only prohibited the importation of the well-known phallic chalk idols from New Ireland, but in the Government Museum of Auckland all ithyphallic idols and figures have been castrated and mutilated." We hope that the Curator of the Museum will state how far this is or is not the case.

In the second number of the useful *Centralblatt für Anthropologie Ethnologie*, &c., is an article on the Necropolis of Novilara near Pesaro. According to Dr. P. Orsi the civilisation of Novilara was partly similar to and synchronous with that of Villanova. Three different culture streams have overlaid themselves, as it were, on the local substratum, and have contributed to give the Picinian culture its final form. One stream came from the north and west over the Apennines. The second came from the south, bringing with it the geometric vessels, which are wanting at Villanova, but appear in Istria; later this culture stream, which may be called the Greek one, brought Tarentinian silver coins and vases painted with black figures. The third stream is the Phœnician (partially also archaistic Greek) associated with figures of Astarte, glass beads and sepulchral steles with representations of naval war. The Necropolis belongs to the ninth to the seventh century B.C.

Bulletin de la Société des Naturalistes de Moscou, 1895, No. 4.—On adhesion of different metals to glass and other substances, by J. Weinberg, second article, in German.—On the winter flora of Nice, note by H. Trautschold.—Report on herborisation in the government of Smolensk, by A. Jaczewski.—The primary skeleton of the ventral fins of the Teleostei, by N. K. Kolzoff, in German, with illustrations; based on the study of thirty-six species.

SOCIETIES AND ACADEMIES.

London.

Royal Society, June 4.—"The Hysteresis of Iron in a Rotating Magnetic Field." By Francis G. Baily.

By deduction from the Weber-Maxwell-Ewing theory it has been surmised that the hysteresis in magnetic metals under the influence of a constant rotary magnetic field will be less than that in an alternating field in which the magnetising force passes through a zero value. It is supposed that residual magnetism is due to the combination of molecular magnets in stable magnetic arrangements, and that the energy dissipated in any magnetic change corresponds to the work done in breaking up these arrangements. Hence any movement of the molecular magnets during which the formation of new combinations is checked or prevented will take place with considerable reduction in the energy loss due to this cause. Such a condition is realised when the magnetic substance is subjected to a rotary magnetic

field of sufficient strength to force the molecules to maintain a direction parallel to that of the field. If hysteresis is due only to the formation of new combinations and not to mechanical restraint, then under these conditions it will vanish altogether.

Experiments were carried out to verify this deduction. A finely laminated cylinder of iron was suspended on its axis between the poles of a rotating electro-magnet, but was restrained from continuous rotation by a spring. On rotating the magnet, the armature was dragged round until the restoring force of the spring equalled the force due to hysteresis, and the value of the latter could be obtained from the observed deflexions. At first the value of the hysteresis was higher than that in an alternating field for corresponding inductions, but at an induction of about 16,000 in soft iron and 15,000 in hard steel the hysteresis reached a sharply defined maximum and rapidly diminished on more complete magnetisation, until at an induction of about 20,000 it became very small with every indication of disappearing altogether. Soft iron and hard steel gave very similar curves, and in both the curve of hysteresis-induction cut the curve obtained from the values in an alternating field at a point just before the maximum. The result fully bears out the deduction from the theory, and proves in addition that hysteresis is not sensibly due to anything of the nature of mechanical restraint of the molecules. The form of the curve also gives clear indications of the three stages of molecular movement, the first stage giving a slowly rising curve, the second a straight rapid rise, and the third a straight and much more rapid descent.

Further experiments were carried out on the effect of speed of rotation. In an alternating field the speed of reversal has been shown to be without sensible effect on the hysteresis, and theory points to this result as a natural deduction. From an extremely slow speed up to seventy revolutions per second no definite change was found in the value of the hysteresis. At the same time several small modifications were noted, produced by rapid variations in the speed of rotation or magnetising force. The effect lasted through many revolutions, but ultimately the same steady condition was arrived at. At and near the maximum value the hysteresis was very variable. The effects were much more marked in soft iron than in hard steel, as would be anticipated from the theory of their constitution.

June 11.—"The Relation between the Refraction of the Elements and their Chemical Equivalents." By Dr. J. H. Gladstone, F.R.S.

This paper is intended to give a preliminary account of some recent investigations into the specific refraction of the elements. The first part contains the atomic weights, with the specific and atomic refractions of fifty-five of the elements.

The specific refraction cannot claim a constancy equal to that of the atomic weight. Several of the elements exhibit two or more values, besides many smaller variations scarcely, if at all, beyond the limits of experimental error, which depend upon differences of physical condition or chemical combination.

The second part deals with a law previously suggested by the author, namely, that the "specific refractive energy of a metal is inversely as the square root of its combining proportion." The product of these two quantities as determined from their compounds is found to be for 5 univalent metals about 1·3, for 10 bivalent metals about 0·99, for 7 trivalents about 1·01, for 6 quadrivalents about 1·06, and for one quinquivalent 0·98.

The observations show: First, that the metals which have the same valency, have the same, or nearly the same, constant of refraction for equivalent weights. Secondly, that the constants of the bivalent, trivalent, quadrivalent, and apparently quinquivalent groups are practically the same, ranging about 1·01. Thirdly, that when a metal combines in a proportion that indicates a lower valency than that ordinarily assigned to it, its constant is somewhat elevated.

The relation involved is not between the optical property and the atomic weight, but between it and the electro-chemical equivalent.

It is proposed to give this product the descriptive name, "Refractive constant of equivalent weights." It may be represented by—

$$SE^{\frac{1}{2}} = \text{constant, or by } S^2E = \text{constant},$$

where S is the specific refraction, and E the chemical equivalent of the metal.

The Lorenz expression for S may be equally used if preferred.

This is suggested as a first approximation to a law, which holds good, however, only for the metallic elements, and that when they are electro-positive radicals.

"The Effects of a strong Magnetic Field upon Electric Discharges in Vacuo." By A. A. C. Swinton.

This paper deals with some effects of a strong magnetic field upon electric discharges in vacuo.

A pear-shaped Crookes' tube was suspended with the kathode terminal uppermost above the pole of a very powerful electro-magnet.

When the magnet was not excited the walls of the tube showed everywhere green fluorescence, which was especially strong over the rounded end of the tube opposite the kathode. When the magnet was magnetised, the whole appearance of the discharge was found to alter immediately to what is shown in the illustration (Fig. 1). Excepting for a little near the kathode and

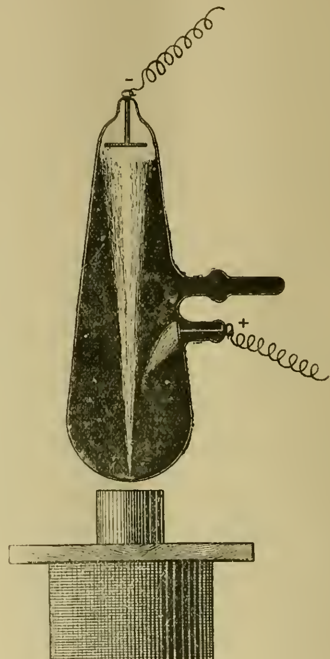


FIG. 1.

a very bright spot at the bottom immediately over the centre of the magnet pole, all the green fluorescence disappeared, while extending from near the kathode to the bright spot at the bottom of the tube a very bright cone of blue luminescence made its appearance.

When under these conditions the tube was moved sideways, the bright spot at the apex of the cone and the cone itself moved, the spot and apex always maintaining a position exactly over the centre of the magnet pole.

At the same time, while the magnet was excited, the internal resistance of the tube as measured by an alternative spark gap was found to be very greatly diminished.

On demagnetising the magnet the appearance of the discharge and the resistance of the tube immediately reverted to what they had been previously. The effect was quite independent of the polarity of magnet pole, and when the position of the tube was

reversed, so that the kathode was next the magnet, the excitation of the magnet reduced the resistance of the tube as formerly, the green fluorescence at the same time disappearing; but the blue luminescence, instead of being concentrated into a cone, was diffused throughout the whole interior of the tube.

[Since the above paper was written, further experiments have revealed the following additional facts.

With a tube of the form shown, exhausted to an extent that gave X-rays plentifully under ordinary conditions, and supported over an electro-magnet as shown in Fig. 1, the X-rays disappeared as soon as the magnet was excited, but reappeared the moment the magnet was demagnetised.

With another tube of similar form but furnished with an inclined platinum plate forming the anode placed near the bottom of the tube, similar results were obtained. This tube being kept on the pump was further exhausted to a degree that allowed the electric discharge to pass with difficulty when the magnet was not excited, and under these conditions gave X-rays of a character that penetrated the bones of the hand almost as easily as the flesh with but little contrast. With this exhaustion the excitation of the magnet not only caused the kathode rays to focus on the platinum, thus giving sharper shadows, but at the same time had precisely the same effect as lowering the vacuum in so far as the moment the magnet was excited the X-rays became more plentiful, and became of such a character as to penetrate the flesh with much greater ease than the bone, so that the contrast between bone and flesh was exceedingly marked. A photograph of the hand taken with one minute's exposure with the tube in this condition, and with the magnet excited, though considerably over-exposed, proved to be a very good one. Further investigations are in progress, but the application of a strong magnetic field in the manner described, gives promise of having considerable practical utility, not only in so far as it facilitates the accurate focusing of the rays proceeding from a flat kathode upon any desired point of the platinum anode, but also and more especially because by employing a high exhaustion and by varying the intensity of the magnetic field, it is possible at will to arrive with ease at the exact conditions requisite to produce a maximum of X-rays of exactly the penetrative character that may be best for any given purpose, a result which hitherto has been difficult of attainment.—A. A. C. S., July 7.]

June 18.—"A Magnetic Detector of Electrical Waves, and some of its applications." By E. Rutherford, 1851 Exhibition Science Scholar, New Zealand University, Trinity College, Cambridge.

The effect of Leyden jar discharges on the magnetisation of steel needles is investigated, and it is shown that the partial demagnetisation of strongly magnetised steel needles offers a simple and convenient means for detecting and comparing currents of great rapidity of alternation.

The partial demagnetisation of a collection of fine steel wires, insulated from each other, and over which is wound a small solenoid in series with the receiving wires, was found to be a sensitive means of detecting electrical waves at long distances from the vibrator. A small but quite marked effect was obtained at a distance of half a mile from the vibrator.

A fine steel wire detector was found to be of the same order of sensitiveness as a bolometer for investigating waves along wires.

This detector has the property of distinguishing between the first and second half oscillations of a Leyden jar discharge, and may be readily used for determining the damping of oscillations. The absorption of energy of spark gaps of different lengths is investigated.

The resistances of iron wires for high frequency discharges are quantitatively determined. The permeability of the different specimens is deduced, and it is shown that the calculated value of the permeability varies greatly with the diameter of the wire and the intensity of the discharge.

A method of experimentally determining the period of oscillation of a discharge is based on the division of a rapidly alternating current in a multiple circuit, one arm of which is composed of a standard inductance, and the other of a variable electrolytic resistance.

PARIS.

Academy of Sciences, June 29.—M. A. Cornu in the chair.—Some properties of the secondary roots of prime numbers, by M. de Jonquières.—Formulæ for the coefficient of internal friction in gradually varied flow of liquids, by M. J. Boussinesq.—Remarks by M. Appell on presentation of his work on "The principles of the theory of elliptic functions and their applications."—M. Albert Goudny announced the death of Sir Joseph Prestwich, correspondent of the Academy in the Section of Mineralogy.—M. Bakhuyzen was elected a correspondent for the Section of Astronomy.—Report on a memoir of M. Bazin, entitled "New experiments on the distribution of velocities in pipes."—Control of the results obtained by the dynamometric pedal of the bicycle, by M. Bouny. Experiments in which the work done was measured at the same time on the brake and by the dynamometric pedal, showed that about 95 per cent. of the work exerted on the pedals was shown by the brake, the remaining 5 per cent. being absorbed by the friction of the axes of the pedals, the chain, and the axis joining the cranks.—Actinometric experiments made on Mont Blanc with a view to determine the solar constant, by M. J. Vallot. Simultaneous observations were made at Chamounix and at the summit of Mont Blanc. Two types of instrument were used, the absolute actinometer of M. Violle, and the mercury actinometer of M. Crova. Extremely concordant results were obtained, giving as a mean value 1·70 for the solar constant.—On rays when $\lambda = 0$, by M. C. Maltézos.—On the spectrum of phosphorus in fused salts and in certain metallurgical products, by M. A. de Gramont. Fused phosphates submitted to the action of a condensed spark, give a fine spectrum of the lines of phosphorus of greater clearness and intensity than the spectrum given by a Plücker tube containing phosphorus. The same method showed easily the presence of phosphorus in alloys, as little as 2 per cent. being readily recognised by the characteristic triplet in the red.—On the blue nitrodisulphonic acid and some of its salts, by M. Paul Sabatier.—Action of iodine upon stannous chloride, by M. V. Thomas. Mixed addition products, similar to those obtained with bromine, were not found, the reaction taking a different direction according to the equation

$$3SnCl_2 + 7I_2 = 3SnI_4 + 2ICl_3.$$

Thermal researches on the uranium compounds, by M. J. Aloy. The heats of solution and formation of some of the commoner uranyl salts.—New method for the preparation of aromatic aldehydes, by M. L. Bouveault. The hydrocarbons are converted into glyoxylic acids by means of ethoxalyl chloride in presence of aluminium chloride, and these heated with aniline give nearly quantitative yields of phenylimides, the condensation to the phenylimido-acid and elimination of CO_2 from the latter proceeding simultaneously. A good yield of the corresponding aldehyde is obtained on hydrolysing the phenylimide by boiling with dilute sulphuric acid. The aldehyde group has in this way been introduced into toluenes m-xylene, cymene, anisol, di-methyl ether of resorcinol, and of di-methyl-hydroquinol.—Researches on the chlorination of gallic acid. Formation of dichlorogallic acid and of trichloropyrogallol, by M. A. Biétrix.—Crystallographic properties of benzylidene, methylsalicidene, ethylsalicidene, and anisol camphors, by M. J. Minguin.—On isaric acid, a new unsaturated fatty acid, by M. A. Hébert.—Digestive apparatus of *Brachytrypes membranaceous*, by M. Bordas. This has many points of resemblance with the *Gryllotalpa*, but differs from this species by the atrophy of the œsophagus, the reduction of the intestinal appendices, and especially by the great length and numerous circumvolutions of the intestine proper.—On a coloration of hepatic origin in the oyster, by M. J. Chatin.—Petrographical study of the meteoric stone that fell at Madrid, February 10, 1896, by M. Gredilla y Gauna. In the metallic portion schreibersite, ivoilite, and chromite were recognisable, whilst the stony portion contained the minerals peridote, enstatite, augite, plagioclase-oligoclase felspar, and olivine.—The grotto of Spelugues, by M. E. Rivière. This cave was discovered during the construction of a railway near Monte-Carlo, and contained human bones, apparently from nine individuals. Other bones represented the remains of animals resembling fox, hare, and sheep. The conclusion is drawn that the race of men represented by these remains lived in the Neolithic period, and are quite distinct from the race whose remains have been found in the cave of Mentone.—On an electric variation determined in the acoustic nerve when excited by sound, by MM. H. Beauregard and E. Dupuy.—Action of diverse substances upon the movements of the stomach, and the ennervation of that organ, by M. F. Battelli. Of all the substances examined, muscarine, pilocarpine, and physostigmine exercised the most energetic effect upon the movements of the stomach. Less energetic are nicotine and other alkaloids, alcohol, and peptone; whilst purgatives, strychnine, and pepsine were without action.—On specific heats, by M. J. Taupin.

PHILADELPHIA.

Academy of Natural Sciences, June 9.—Papers under the following titles were presented for publication:—"Contributions to a knowledge of the Hymenoptera of Brazil," by Wm. J. Fox; "The Correct Position of the Aperture of Planorbis," by Frank C. Baker; "The Mesenteries of the Lacerti ia," by E. D. Cope; "Revision of the Slugs of North America—Ariolimax and Aphallarion," by Henry A. Pilsbry and E. G. Vanatta.—Dr. Harrison Allen made a communication on forms considered specific, but which were merely instances of arrested development. He referred in illustration to certain species of *Vespertilio*, claiming that *Lucifugus* is merely an arrested form of *Gryphus*, the species *Albescens* also being based on similar characters. He had applied the term pædomorphism to the condition which had been worked out, he believed, only among the bats, and by himself. He held that the specific names of such forms were not valid, and should be dropped. Dr. George H. Horn stated that many such instances of arrested development were found among insects. He referred to the dimorphic males of *Eupsalis minuta*, a rhyncophorous beetle on which a French writer had founded three species. The egg-depositing habits of the female, and the assistance rendered when necessary by the male, were commented on.

June 8 (Botanical Section).—A paper was read from Mr. Thomas Meehan on *Erigeron strigosus*. A tendency of the ray florets to become discoidal, together with an acceleration from the lingulate to the discoid condition, was noted. The hermaphrodite state of the flower is not established until the tubular condition becomes permanent.—Dr. Ida A. Keller recorded the fact that if a cold alcoholic solution of chlorophyl be treated with benzol, the chlorophyl will be extracted and float as a green film on the surface of the liquid.

NEW OUTH WALES.

Linnean Society, May 27.—Mr. Henry Deane, President, in the chair.—Observations on Peripatus, by Thomas Steel. In this paper was embodied an extended series of observations on the habits and characteristics, food supply and life-history, with remarks on the individual range of colours, and relative proportions of the sexes, based on the examination of numerous living specimens of various ages kept under continuous observation for more than a year.—Descriptions of new Australian Fungi, (No. 1), by D. McAlpine.—Description of a new species of *Astralium* from New Britain, by C. Hedley and Dr. Arthur Willey. *A. moniliferum* (n. sp.), allied to the Japanese *A. triumphans*; dredged in 30 to 40 fathoms on a shelly bottom.—On a rare variation in the shell of *Pterocera lambis* (Linn.), by Dr. Arthur Willey. A series of sixty-seven specimens of this common tropical species from New Britain and the Eastern Archipelago of New Guinea has been examined. Numerous instances of substantive variation were met with, the more striking of which relate to the curvature of the digitations, their length, the intervals between them, and the extent to which the apical whorls of the shell are involved in, concealed by, or fused with the posterior digitation. There is also much variation as to the stage of growth at which the deposition of callus on the outer lip of the shell takes place.

AMSTERDAM.

Royal Academy of Sciences, May 30.—Prof. van de Sande Bakhuyzen in the chair.—Prof. Hubrecht gave a description of the embryonic vesicle of *Tarsius spectrum*, and pointed out its close resemblance to that of man and monkeys. From this and from the placentation the author concluded that the order of Primates should henceforth embrace only the Hominidæ, the Siniæ, Tarsius, and the fossil Anaptomorphus. He was, moreover, disinclined to admit the possibility of deriving the placental arrangements, and the peculiarities of the clastocyst of the Primates from what is presented by the *Lemures*. The Primates should be derived from certain unknown insectivorous mammals of the Mesozoic period, of which the recent Erinaceus and Gymnura might perhaps prove to be the least distant relatives.—Prof. Pekelharing described a new method of preparing pepsin.—Prof. Schoute read a paper on the area of parabolæ of higher order, and, on behalf of Prof. Holleman, a communication to the effect that already some months ago he obtained the isophenylnitromethane recently described by Hantzsch and Schulze, and that his results were identical with those arrived at by these chemists. Mr. Holleman has also studied the reaction between benzoylchloride and the sodium compound of phenylnitromethane, and in doing so obtained dibenzohydroxamic acid.—Prof. Franchimont described isomers of neutral nitramines. They were obtained by Mr. van Erp both from the potassium compounds and the silver compounds of the acid nitramines; in the first case as a secondary product, in the second case as the principal product. Their boiling points and their specific gravity are lower than those of the nitramines; moreover, they are strongly affected by sulphuric acid, with the formation of gases, which is not the case with nitramines. By decomposition with alkali solutions, butylmethylnitramine yielded butylamine, while the isomer produced butyl alcohol; so that it seems as if in the first case butyl is united with nitrogen, in the second with oxygen. By the action of methylnitramine potassium upon allylbromide, Dr. H. Umbgrove obtained, besides allylmethylnitramine, also an isomer with a lower boiling-point, and acting violently upon sulphuric acid. A similar isomer seems also to be produced, in addition to ordinary dimethylnitramine, when methylnitramine is heated by itself, while nitrous oxide escapes. When heated with β-naphthol nitrogen escapes, and β-naphtholmethyl ether is formed, besides colouring matters.—Prof. Kamerlingh Onnes presented a communication concerning the measurement of low temperatures, and (on behalf of Mr. E. van Everdingen, jun.) (1) remarks on the method of observing Hall's effect; (2) measurements on the dissymmetry of Hall's effect in bismuth, and on the average Hall-effect in bismuth and antimony, carried out in the Leyden physical laboratory.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Skertchly's Physical Geography, revised edition (Murby).—Practical Radiography: H. S. Ward ("Photogram," Ltd.).—Beginner's Guide to Photography, 6th edition (Perken).—The Universal Law of the Affinities of Atoms: J. H. Loader (Chapman).

PAMPHLETS.—Absolute Oder relative Bewegung?: Dr. B. and I. Friedlaender (Berlin, Simion).—The Position of Argon and Helium among the Elements: Prof. W. Ramsay (Frowde).

SERIALS.—Lloyd's Natural History. Butterflies: W. F. Kirby. Part 2 (Lloyd).—Scribner's Magazine, July (Low).—Humanitarian, July (Hutchinson).—Journal of the Royal Agricultural Society of England, Vol. vii Part 2, No. 26 (Murray).—A Monograph of the Land and Fresh-water Mollusca of the British Isles: J. W. Taylor, Part 3 (Leeds, Taylor)—Bulletin de la Société de Géographie, 4e Trimestre, 1895 (Paris).—Astrophysical Journal, April and June (Chicago).—Fortnightly Review, July (Chapman).—Sitzungsberichte der Physikalisch-Medicinischen Societät in Erlangen, 27 Heft. 95 (Erlangen).—Proceedings of the Society for Psychical Research, June (K. Paul).—Westminster Review, July (Warne).—Geographical Journal, July (Stanford).—Annals of Scottish Natural History, July (Edinburgh, Douglas).—Mind, July (Williams).

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THURSDAY, JULY 16, 1896.

THE ZOOLOGICAL RESULTS OF THE HORN SCIENTIFIC EXPEDITION TO CENTRAL AUSTRALIA.

Report on the Work of the Horn Scientific Expedition to Central Australia. Part ii. Zoology. 4to, pp. 431, plates 29. (London: Dulau. Melbourne: Melville, 1896.)

IT is becoming quite the fashion, we are glad to say, nowadays for private individuals who possess the necessary means, to send out scientific expeditions at their own cost. This laudable practice has long been prevalent in the United States, where, many years ago, the expense of Louis Agassiz's journey to South America was borne by a friend interested in science. In England we have at present the "Jackson-Harmsworth Expedition" to Franz-Josef Land generously sustained by Mr. Harmsworth; and other examples of similar munificence are well known. Our more advanced colonies are now following these excellent precedents, and the entire cost of the successful expedition into Central Australia, of which some of the results are now before us, has been borne by Mr. William Austin Horn, of Adelaide, who, we believe, also devised the plan of it. But not only was the plan Australian and the means to carry it out provided in Australia, but the members of the expedition were Australian, the results have been worked out in Australia by Australians, and the reports on the results printed, illustrated, and published in Australia. Australia may therefore be well proud of the Horn Expedition, and thankful to Mr. Horn for having projected it and carried it out.

It having been suggested by scientific men that in the last geological epoch, when the rest of the continent was submerged, the MacDonnell Ranges in Central Australia existed as an island, and that, consequently, older forms of life might still be found in their more inaccessible parts, Mr. Horn determined to try and solve this question in a practical manner. His proposal was received with great favour all over Australia, and Mr. Horn was fortunate enough to secure the services of Prof. Spencer of Melbourne, Mr. Watt of Sydney, and Prof. Tate and Dr. Stirling of Adelaide to carry it out. Mr. Winnecke was selected as surveyor and meteorologist. The party, completely equipped and accompanied by camel-drivers, collectors, prospectors, and others—sixteen in all, with twenty-six camels and two horses—left Oodnadatta, the northern terminus of the railway from Adelaide, on May 6, 1894. Mr. Horn himself escorted them to a point 1000 miles north of Adelaide. Here he left them to proceed into the recesses of the "Eremian region," where they devoted about three months to their explorations. The greater part of this time was spent in what is termed the "Larapintine" district, where the MacDonnell Ranges run up to an altitude of 5000 feet, and are drained by the Finke River, of which the native name is the Larapinta. We will now proceed to examine the results arrived at from the study of the zoological collections made by the expedition in this district.

The volume before us contains articles on the Mammals, Amphibians and Crustaceans, by Prof. Spencer; on the Birds, by Mr. North; on the Reptiles, by Messrs. Lucas and Frost; on the Fishes, by Mr. Zietz; and on the Molluscs, by Prof. Tate. Various leading groups of Insects are reported on by Mr. Lower, the Rev. T. Blackburn, Mr. Tepper, Mr. Sloane, and Mr. Froggatt. Mr. H. R. Hogg writes on the Spiders, and Mr. Waite specially on the difficult group of Mice (Muridæ). There are some additions made in an appendix.

From Prof. Spencer's report on the Mammals we learn that examples of twenty-six species, representing all the five orders of Mammals met with elsewhere in Australia, were secured, of which the Marsupials were naturally the most numerous, twelve of the species being referable to this group. Four of these are assigned to new specific forms, which Prof. Spencer has named *Phascologale macdonnellensis*, *Sminthopsis larapinta*, *S. psammophilus*, and *Dasyuroides byrnei*. The so-called "Marsupial Mole" (*Notoryctes typhlops*) is the single representative of the only family of Marsupials confined exclusively to the "Eremian region." This little animal is still extremely rare and difficult to obtain, but more than forty specimens have passed through Prof. Spencer's hands, and some interesting details are given about it. Dr. Stirling, its original discoverer, and Prof. Spencer are now engaged upon an investigation of its teeth, fur, and reproductive organs.

As regards the latter, Prof. Spencer has already come to the conclusion that *Notoryctes* is "merely a Marsupial modified so as to adopt the burrowing habits," and is "in no manner whatever an intermediate form between Monotremes and Marsupials."

The bird skins obtained during the Horn Expedition by Mr. G. A. Keartland are reported upon by Mr. North, the ornithologist of the Australian Museum, Sydney. They are referred to seventy-eight species, amongst which are five novelties already described in *The Ibis* for 1895. Mr. Keartland's useful field-notes are given, as also his remarks on twenty-two other species observed, but of which no specimens were obtained. As a rule, the species belong to well-known Australian genera. One of the most remarkable is the Alexandrine Parrakeet (*Polytelis alexandræ*), described by Gould in 1863, of which little, however, was known until recently. This beautiful bird appears to be a characteristic inhabitant of the Eremian district, and was met with in abundance at Glen Edith. Mr. North has made a new genus of it—*Spathopterus*—which appears to be quite unnecessary. We may add that living specimens of it, of both sexes, are now to be seen in the Zoological Society's parrot-house.

The Reptiles of the Horn Expedition consist of Lizards and Snakes. The former are referred by Messrs. Lucas and Frost to forty species, amongst which, however, are counted some specimens obtained by Prof. Spencer [during a second visit to the same district in the winter of 1895. In the dry and hot interior of Australia, Lacertine life is, as was to be expected, abundant, both in individuals and in species, and eight forms are described by the authors as new and characteristic of the Eremian district. The Geckos, Agamids, and Skinks are the prevailing families here, as in the rest of Australia. Besides these no less than six species of

Varanus were met with, of which two are believed to be previously unrecognised. The remarkably ugly *Moloch horridus* was met with "in the open, during the day," throughout the expedition. The Snakes were not so numerous as the Lizards, but *Hornea pulchella*, a new genus and species of Elapidæ, was amongst the discoveries.

It would hardly be supposed that Central Australia would be a likely place for Amphibians, but wherever there were water-holes frogs were found in fair numbers, and Prof. Spencer gives us some very interesting remarks on them. Almost all of them belonged to two species—*Hyla rubella* and *Limnodynastes ornatus*. On visiting Charlotte Waters immediately after a heavy rainfall, Prof. Spencer found the "creeks and clay-pans swarming with frogs." As the waters dry up, the frogs disappear in their burrows, and remain hidden until rain comes again. Certain species of them (*Chiroleptes platycephalus* and others) gorge themselves with water before they go into their retreats, and in times of drought the natives dig them out and secure water enough from their bodies to satisfy thirst. Prof. Spencer gives a figure (Pl. xiv., Fig. 9) of a specimen of the above-named species with its "body swollen out with water."

As the frogs, so the fishes of the Eremian district hide themselves in the deeper water-holes, but they are not known to burrow. Examples of seven species were obtained, five of which, representing four genera, are new to science, and are described as such by Mr. Zietz.

Prof. Tate, one of the members of the expedition, himself describes the Mollusca. Before the advent of the party, the published information respecting the land-shells of this region was limited to three species, which number is now increased to twenty-five—nearly all of them new to science. The facies of this part of the Fauna approximates rather to that of West Australia, than to any other part of the continent.

> "The limited number of genera represented, together with the facts of their distribution, seem to indicate a primitive population which has been maintained in isolation by climatic and geological changes."

One genus (the Central-Australian Mollusca) was previously known only from New Caledonia. Mr. Hedley adds to Prof. Tate's article notes on the anatomical structure of some of the species.

For an account of the Crustacea of the Horn Expedition, we are again indebted to Prof. Spencer, who remarks that the rate of growth of some of the species must be very great. Not more than two weeks after rain had first fallen, and probably in only a few days, numberless specimens of an *Apus*, measuring from two to three inches in length, were swimming about in the water-holes, whereas before the rainfall not a single one could be found. Ten species of Crustacea in all were met with, *Estheria packardi* being the most widely distributed; whilst two (*Limnadopsis squirei* and *L. tatei*) are, so far as is yet known, confined to the central region.

We need not go deeply into the various groups of insects which are the subjects of most of the remaining pages of the volume. Butterflies are rare in Central Australia, and examples of only five (already known) species were met with, and of moths specimens of only about fifteen species were captured. On the other hand, 800 specimens of Coleoptera, representing 145 species, were obtained, and of these sixty-two are new, and four of them belong to new genera. The Coleoptera were worked out by the Rev. T. Blackburn, of the South Australian Museum, except the Carabidæ, which Mr. Sloane undertook. Mr. J. G. O. Tepper informs us that the Orthoptera brought back by the expedition present few novelties, but that the knowledge acquired as to the distribution of the species is valuable. As regards the Formicidæ, a special essay is contributed by Mr. Froggatt on the Honey-ants. It is perhaps little known, except amongst professed entomologists, that certain species of this group have adopted the curious plan of "turning some of their fellows into animated honey-pots." Instead of placing honey in a comb as the busy bees do, the ants select a certain number of workers, and disgorge the honey obtained from the Eucalypti (on which it is deposited by Coccidæ and other insects) into the throats of their victims. The process being continually repeated, causes the stomachs of these workers to be distended to an enormous size. This extraordinary habit was first discovered in the case of certain ants in Mexico, and subsequently shown by Mr. M'Cook to prevail also in Colorado. It has been found to exist in Australia also, and Mr. Froggatt describes and figures three ants of the genus *Camponotus* that pursue this remarkable practice. The enormous size of the abdomen thus acquired by the unfortunate worker is shown in the central figure of Plate xxvii. These ants are a favourite food of the hungry native.

To sum up, we may repeat that this volume, which is well printed on good paper and excellently illustrated, does the greatest credit to Australia and to its enterprising citizens. They may well be pleased with Mr. Horn, who has not only planned and executed this important piece of work, but has also exerted himself so successfully on a point that is too often neglected in such undertakings — that is, on having the results thoroughly well worked out, and thus made known to science all over the world.

THE WATER SUPPLY OF NEW YORK.

The Water Supply of the City of New York, 1658–1895. By Edward Wegmann, C.E. (New York: J. Wiley and Sons. London: Chapman and Hall, 1896.)

THIS work consists of a quarto volume of nearly 200 pages, with appendices and 148 plates, in addition to seventy-three figures in the text.

It was not until the year 1842 that the citizens of New York were able to celebrate the completion of their first water-works of importance. The works then constructed soon proved inadequate to the supply, and have had to be supplemented from time to time from other sources.

In view of the agitation which is now going on for improving the water supply of London, the particulars given in this book, of the various steps which have been taken for providing an adequate supply to the City of New York, are of considerable interest.

In 1875, the then source of supply being found in-

sufficient, the Department of Public Works submitted plans for new water-works. The reports on these plans were submitted by the Mayor to the Legislature. The Senate requested the Mayor to nominate five citizens who, in conjunction with himself, were to report on the best scheme to be adopted. After holding thirty-three public meetings, at which eminent engineers and citizens expressed their views with reference to the proposed works, a scheme was approved and adopted, the source of supply being the Croton River, from which the water hitherto in use has been obtained. They also advised that the works should be entrusted to "an unprejudiced Commission selected from the best citizens of the city." The Committee drew up a draft Bill embodying these recommendations, which formed the basis of "An Act to provide new reservoirs, dams, and a new aqueduct with the appurtenances thereto for the purpose of supplying the City of New York with an increased supply of pure and wholesome water," which was passed by the Legislature in 1883. An "Aqueduct Commission" was appointed, consisting of the Mayor, the Comptroller, the Commissioner of Public Works *ex officio*, and three citizens, the salary of each of the Commissioners being fixed at 8000 dollars (£1680) a year. The works carried out will be referred to later on.

The book under notice, which has been prepared by Mr. Wegmann, one of the engineers of the Water Commission, gives the history of the water-works of the City of New York from the sinking of the first public well in 1658 to the present time, and full technical details of the new works. This description cannot fail to be of interest to engineers engaged in water supply, and the great number of illustrations of the details of the construction, as showing the difference between English and American practice, are instructive, and may even give hints for the adoption of new methods of carrying out works of a similar character in this country.

Within about 300 years the population of New York has increased a thousand-fold, the number of inhabitants in 1664 being 1500, and now 1,515,301.

The first attempt at a public water supply was in 1658, when "the Burgomasters resolved to communicate with the Herr General relative to having a public well made in Heere Street," and subsequently six public wells were sunk. As the population increased, the well-water became polluted, and the inhabitants had to send to springs situated on the outskirts of the city for pure water. One of the most noted of these springs was known as the "Old Tea-water Pump," which is thus described in the diary of a traveller in 1748.

"There is no good water in the town itself, but at a little distance there is a large spring of good water, which the inhabitants take for their tea and for the uses of the kitchen. Those, however, who are less delicate on this point, make use of the water from the wells in the town, though it be very bad."

When the population had increased to 22,000, the Common Council of the city accepted a proposal of an English engineer, Christopher Colles, to construct a reservoir on Manhattan Island for supplying the city with water. The water was pumped up by one of Newcomen's atmospheric engines, and distributed through mains consisting of hollow logs. Owing, however, to the insufficiency of the supply, and the confusion caused by the Revolution, this enterprise became abandoned. The next scheme for supplying the city with water was due to an Act of the Legislature, which, under the guise of incorporating a company for supplying the city with pure water, really was for the purpose of establishing the Manhattan Bank, the company being authorised by the Act to raise a large amount of capital, and employ it "in any other moneyed transactions or operations not inconsistent with the constitution and laws of the State." Only enough was done in introducing water to maintain the charter, the real object of the incorporation being the formation of the bank, to which there had been very strong opposition. For several years after this the water supply of the city remained in a very unsatisfactory state, and numerous schemes for providing a better supply were brought forward. From documents published in 1832 it appears that the quality of the water then used did not conduce to temperance, as one of the arguments used in favour of a new supply was: "By thus supplying the inhabitants with fine pure rock water, it will remove the popular pretext for using alcohol to correct the impurities of the water now in general use, and will be the most effectual means of promoting the great and noble cause of temperance in this city." The temperance cause seemed to occupy a considerable amount of public attention at this time, as in one of the contracts made for the construction of the new water-works was a clause to the effect that the contractor should not sell or allow to be sold any ardent spirits to their workmen, or to any person near the line of the works.

In 1834 an Act was passed forming a permanent Water Commission, and providing for the raising of £325,000 for constructing water-works. The Croton River was decided on as the source of supply. This river is situated thirty-three miles from the city. The water-shed above the dam has a ridge line of 101 miles, and an area of 532 square miles. Within this area are contained thirty-one natural lakes and ponds. The length of the river is thirty-nine miles, and its minimum flow above the dam 33,804,000 gallons. The average rainfall is 42·68 inches, the minimum being 38·52 inches.

The first, or "Fountain," reservoir was formed by constructing a dam across the river six miles above its mouth. The lake is four miles long, and has a width of about a quarter of a mile. Its area is 400 acres, and storage capacity 600 million gallons. The water was conveyed to the city by a masonry aqueduct a distance of thirty-three miles. The masonry conduit is 7 feet 6 inches in diameter with upright sides, and has an area of 53·34 feet. When the water was first admitted in 1842, a boat containing four persons was placed in the current, and arrived almost simultaneously with the water at the Harlem River, the velocity of the current being at the rate of one mile in forty minutes. The mean fall of the invert is at the rate of 0·6 feet per mile. The aqueduct is capable of discharging ninety-five million gallons in twenty-four hours. The distributing reservoir, situated three miles from the city, was constructed almost entirely above ground, by means of walls thirty-six to forty-nine feet above the surface. This reservoir is 420 feet square, and has a depth of water of thirty-six feet, the capacity being twenty-four million gallons. After the works became in

full operation, no restriction being placed on the quantity used, the daily consumption amounted to seventy-eight gallons per head of the whole population, or ninety gallons for each water consumer.

From time to time the works have had to be enlarged and additional reservoirs built, until in 1875 it was determined to build a second aqueduct connected with a new reservoir to hold 1900 millions of gallons.

The new aqueduct, including a short length of pipe line, is thirty-four miles long, twenty-nine miles of which are in tunnel through gneiss rock. This aqueduct is lined throughout with masonry. The standard shape, where not under pressure, is of horseshoe section with a diameter of fourteen feet, the sectional area being equal to a circular masonry culvert having an internal diameter of fourteen feet. The available head is 33·70 feet, which is absorbed in overcoming friction through the conduit and pipes. The grade is at the rate of 0·7 feet per mile, and the velocity of the flowing water 3·27 feet per second. It is capable of discharging 300 millions of gallons in twenty-four hours.

The "Cornell" reservoir, now under construction, will contain when completed 32,000 million gallons. The central masonry dam is 600 feet long, with an earthen continuation of the same length. The maximum height of the masonry dam is 260 feet, the height above the river-bed being 159 feet, the top being 10 feet above the water-line. It is to be 18 feet wide at the top, and 185 feet at the base.

The total capacity of the conduits now supplying the city, which has a population at the present time of one and a half millions, is 425 millions of gallons. The total storage capacity of the reservoir is 75,000 millions of gallons, equal to a minimum supply in the driest years of 280 millions of gallons.

Mr. Wegmann's book is almost entirely of an historical and descriptive character, and is confined entirely to the works carried out for the water supply of New York. The details of these various works are, however, so copiously illustrated that they give the book an eminently practical character, which renders it of value to any engineer engaged in water-works construction.

A NEW CHEMICAL DICTIONARY.

A Dictionary of Chemical Solubilities. Inorganic. By Arthur Messinger Comey, Ph.D. Pp. xx + 515. (London: Macmillan and Co., Ltd., 1896.)

THIS is a book about which it is impossible to get up any feeling of enthusiasm; but one cannot resist a sense of wonder and admiration at the patient, plodding spirit in which the compiler must have set about his weary task, and carried it on through months or years of labour to the dreary end. Of course he is an American. In no other nation of the earth using or abusing the English tongue would a man have been found to undertake such an enterprise; but why the busy, rushing life of that great country across the Atlantic should breed so many compilers of catalogues and bibliographies and indexes, especially of physical science, of books which Charles Lamb would have called no books, *biblia a-biblia*, it seems hard to say. The world ought to feel grateful to them, but usually it does not. It often uses such cyclopædias, though ready enough to grumble if it finds them less than perfect. In this volume the only smack of literary flavour is to be found in the preface, wherein the extract from "Peter Shaw's Chemical Lectures, publickly read at London in 1731 and 1732," shows that the plan of such a book was foreshadowed long before its accomplishment. For, according to the author, the first work that undertook to carry out the idea in its entirety was produced by Prof. F. H. Storer in 1864. All chemists are familiar with Storer's "First Outlines of a Dictionary of Solubilities of Chemical Substances," though long since out of print. It will at once be noticed that there is an important difference in the titles of the two works. Dr. Comey is, however, justified in using the expression "chemical solubilities," inasmuch as he does not confine his work to data concerning solutions in water and alcohol or other neutral solvents, but includes the action, for example, of acids upon metals, and the effects of various liquids, such as solutions of potash and aqueous acids. Moreover, certain physical facts are mentioned, such as changes of temperature on dilution, also any data obtainable regarding the boiling-points of solutions, and tables giving the specific gravities of aqueous solutions.

After all, the more modest title—"First Outlines"—adopted by Storer, seems to assume quite enough; for the materials for such a work amount at present to little more than a most miscellaneous collection of more or less inaccurate estimations of solubilities, without any clue as to the cause of solubility, and theories as to the condition of the dissolved substance still in conflict. This, however, has not deterred the compiler, who, on the whole, has done his work carefully and well. It would, perhaps, help the users—we can hardly speak of readers—of the Dictionary if in a future edition the general statements were somewhat amplified, and gathered together into an introductory chapter apart from the alphabetical array of details concerning particular cases. For example, it is obvious in regard to salts that the solubility in water is determined more by the nature of the negative radicle than of the metal. We can say truly that all nitrates are soluble in water except a few basic compounds, but we cannot predicate anything general concerning the solubility of the compounds, say, of lead. Some of these broad statements are given in the Dictionary, but they might be extended with advantage. A classification of the metals according to the action of water and of acids upon them might be given; it might also be worth while to state what is known of the colours of dissolved inorganic substances, concerning which there are some very curious facts which probably have an important significance could we only find the clue to their explanation.

From what has been said, it is obvious that this volume contains a mass of information brought together from a great variety of sources. It will certainly be found useful not only in the chemical laboratory, but also by the manufacturer and practical man to whom time is money. It may therefore be fairly described as one of those books which no chemist's library should be without.

OUR BOOK SHELF.

A Concise Handbook of British Birds. By H. Kirke Swann. Pp. 210. (London: John Wheldon and Co., 1896.)

THIS is a handy and serviceable reference book on British birds. It includes descriptions of the characteristics, distribution, and habits of every species on the British list, and the information, though brief, is generally sufficient for identification. The classification and nomenclature followed is practically that of the British Ornithologists' Union. The specific names of first describers are, however, adopted, and sub-species or races are distinguished by sub-numbers and trinominals. Ornithologists, and bird-lovers generally, will find Mr. Swann's book of practical value in the field, and very useful for ready reference in the study.

Practical Radiography. By H. Snowden Ward; with Chapters by E. A. Robins and A. E. Livermore. Pp. 80. (The Photogram, Ltd., 1896.)

THERE may be persons who furnish themselves with an outfit for Röntgen photography without having a knowledge of either electricity or photography. For such individuals, possessing aspirations without education in physical principles, this book has been written. The history of kathode rays and Röntgen's discovery occupies seven pages of the book. There is a chapter on the manufacture of an accumulator, and another describing how to make an induction coil. The remaining five chapters are taken up with descriptions of the apparatus and methods of Röntgen photography.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Are Specific Characters useful?

WITH the above title Mr. Alfred Russel Wallace brought before the Linnean Society on June 18 an important communication, which derived additional interest from the fact that he himself was present in full health and vigour, as well as from the presence of a large number of naturalists who have given attention to the questions arising from the consideration of the theory of the origin of species by natural selection.

In the course of the remarks which were offered by his audience at the conclusion of Mr. Wallace's paper, I ventured to point out that the consideration of the class of phenomena which Mr. Darwin had described under the title "correlation of variation," seemed to me to lead necessarily to the conclusion that very often characters which are obvious and distinctive marks of species may be not useful but useless, since such obvious species marks may be only superficial and non-significant phenomena "correlated" (as Mr. Darwin used that term) with other less obvious but really important life-saving peculiarities, which might quite well escape the observation of the describer of "specific characters." As instances of the phenomenon of "correlation," I referred to those cited by Mr. Darwin, such as the concomitance of a development of feathers on the feet with the webbing of the toes in certain breeds of pigeons, the concomitance of abnormal dentition with hairlessness of the body-surface in Chinese dogs, the concomitance of deafness with blue eyes in male white cats. A case which seemed to me most striking and suggestive in connection with the utility of specific characters was cited by me. It was that which had led Wells to propound a doctrine of "natural selection" many years before Darwin and Wallace had placed their views in 1858 before the Linnean Society—a case which Mr. Darwin cited in later editions of the "Origin of Species," and is familiar enough. Wells pointed out in a memoir communicated to the Royal Society in 1813, that persons with dark pigment in the skin are relatively immune to tropical fevers, as compared with fair-complexioned individuals. He argued that owing to this property of dark-skinned varieties of men, there would be a survival selection in tropical regions of such varieties, and that probably, or at any rate possibly, in this manner the black colour of tropical races might be accounted for. I mention this more or less hypothetical case as showing that an obvious and striking character, namely, that of black pigment in the skin, might become predominant, and conceivably might become a "specific character," although the blackness was not in itself a "useful," that is, a "life-preserving or progeny-ensuring" character, but merely the *accompaniment* of a power of resisting malarial germs, which we now have reason to believe consists in a special chemical activity of the leucocytes (phagocytes) of the blood and other tissues. From the consideration of this and other similar cases, I argued that many "specific characters" (that is to say, as defined by Mr. Wallace, characters which individually or in definite association with other characters constantly occur in one species and not in the other species of a genus) must be devoid of utility themselves, and appear merely as the "correlatives" or "concomitants" of really effective life-preserving or progeny-ensuring characters. I insisted, finally, on the very great importance of the correlation of parts in animal organisms, and the necessity of regarding animals (and presumably also plants) as most highly-wrought mechanisms in which no part can vary without the accompaniment of variation in some remote and (in our present state of knowledge) unexpectedly correlated part, and to a degree often excessive and (in our present state of knowledge) unaccountable. Thus, as Mr. Darwin himself pointed out, the selection of a given favourable variation may lead to excessive variation in a remote region of the organism, which in its turn will very often (but not necessarily always or at once) become the subject of further selection. Mr. Darwin appears to have deprecated, in conversation with Mr. Thiselton-Dyer (according to the latter's interesting statement in the debate on Mr. Wallace's paper), the invocation of this theory of "correlation" as an explanation of cases of apparently useless parts in animals or plants when under investigation, holding that our ignorance of the modes in which parts may be serviceable to an organism is so great that we should rather experiment and observe as to their possible utility than advance a theory which dismisses further inquiry. Whilst agreeing with Mr. Thiselton-Dyer as to the "immorality" (as he termed it) of a naturalist who favours theories which paralyse his activity as an observer and experimentalist (on which subject see the last paragraph of this letter), I yet think that, as seekers after true knowledge, we are bound to face the complex problem in all its aspects. The obvious character, as well as many less obvious characters, which we note as distinguishing one species from another, are not improbably, it must be admitted, in many cases concomitant phenomena of some other phenomenon which alone among them is effective in determining the preservation of the life, or the production of progeny in the case of the individuals so characterised.

At the same time I think that it may well be maintained that such secondary or concomitant characters are not long allowed to remain non-significant, and that sooner or later they fall under the moulding action of natural selection, becoming as they increase in volume either useful or injurious.

My chief object in writing this letter is to draw attention to the views of Prof. Weldon, who has for some time, as all zoologists know, been occupied in tabulating a very large series of measurements of growing crabs. When I had stated my views as to the importance of "correlation of variation," with which Mr. Meldola and Mr. Wallace subsequently expressed their complete agreement, Prof. Weldon declared, with some expressions of reluctance and regret—due, as he was good enough to say, from an old pupil to the teacher whom he is about to denounce and demolish—that to attempt to say which of two or more correlated growths is the cause of survival is unreasonable, and that when I suggested, even as a matter for consideration, that a certain germ-slaying quality in phagocytes accompanying a pigmented skin, rather than the pigment itself in the skin, is the cause of the survival of dark-skinned people in malarial regions, I was "absolutely illogical." "It is," said Prof. Weldon, "impossible logically to separate these two correlated phenomena. The coloured skin is as much a cause of the survival of the dark man as is the germ-destroying property of his blood."

I was at the time entirely unable to appreciate the drift of Prof. Weldon's thought. I was not prepared for an empty

wrangle in regard to the proper uses or improper uses of the word "cause." But I did remember that Mill says that the most vulgar form of "the fallacy of generalisation" is that which is expressed by the phrase "*post hoc* or *cum hoc, ergo propter hoc.*" I could not imagine how or why my friend Prof. Weldon had been led to make himself the defiant, not to say jubilant, champion of this fallacy. I have, on reading Prof. Weldon's paper in the *Proceedings* of the Royal Society, vol. lvii. 1894–95, found matter which throws light on the problem. It would appear that Prof. Weldon, in discussing his measurements of crabs, had already publicly adopted the logical position which so much astonished those who heard him at the Linnean Society. It appears that the fallacious process, which consists in ignoring the possibility of two concomitant phenomena being two independent consequences of one set of antecedents, gives an apparent value to the laborious measurement of crabs which, it seems, they would not possess if treated in a rational way. Prof. Weldon says (*loc. cit.*, p. 380): "It is the object of the present remarks to discuss the *effect* of small variations, as it may be deduced from the study of two organs in a single species. The case chosen is the variation, during growth and in adult life, of the dimensions of female *Carcinus mænas.*"

Further on he speaks of "the *effect* of small variations upon the chance of survival," and in close proximity occurs this passage: "The law of growth having been ascertained, the rate of destruction may be measured, and in this way an estimate of the *advantage* or *disadvantage* of a variation may be obtained." And again: "Knowing that a given deviation from the mean character is associated with a greater or less percentage death-rate in the animals possessing it, the *importance* of such a deviation can be estimated without the necessity of inquiring how that increase or decrease in the death-rate is brought about so that all ideas of functional adaptation become unnecessary." The title of the paper drawn up by a Committee, of which Prof. Weldon is a member, and in reference to which his own paper is written, stands: "An attempt to measure the death-rate due to the *selective* destruction of Carcinus mænas *with respect to* a particular dimension."

(The italics in these citations are mine.)

It appears to me that the language which I have italicised indicates that Prof. Weldon—in his interpretation of the fact ascertained by him, viz. that crabs with a particular proportion of frontal breadth are commoner in the adult condition than in younger stages—has deliberately departed from the simple statement which his observations warranted, viz. that such-and-such a proportion of frontal measurement accompanies survival, and has unwarrantably (that is to say unreasonably) proceeded to speak of the "effect" of this frontal proportion, to declare it to be a *cause* of survival, to estimate the "advantage" and "disadvantage" of this same proportion, and finally to maintain that its "*importance*" may be estimated without troubling ourselves to inquire how it operates, *or whether indeed it is operative at all.*

Such methods of attempting to penetrate the obscurity which veils the interactions of the immensely complex bundle of phenomena which we call a crab and its environment, appear to me not merely inadequate, but in so far as they involve perversion of the meaning of accepted terms and a deliberate rejection of the method of inquiry by hypothesis and verification, injurious to the progress of knowledge. E. RAY LANKESTER.

Oxford, June 30.

Are Specific Characters the Result of "Natural Selection"?

THE last meeting—on June 18—of the Linnean Society was one of very exceptional interest, because the survivor of the two illustrious naturalists who, on the same night—more than thirty-seven years ago—first enunciated in that Society's rooms the doctrine of the origin of species by "natural selection," read a highly interesting paper on that very subject.

The title of the paper, by Dr. Alfred R. Wallace, F.R.S., however, was "The Problem of Utility: Are specific characters always or generally useful?" But the author, in treating the question, expressly took for granted (as might surely have been expected of him) the doctrine common to him and the late Mr. Darwin. So the question was implicitly answered at once; for if species arise by "natural selection," then those characters which constitute them species must be due to the same cause, *i.e.* to utility. Thus the question really raised by Dr. Wallace was the old one, "Do species arise through 'natural selection'?"

This old question having been thus again started by its oldest advocate, a few words in reply to it may be permitted to one of its oldest opponents. Not that I was always an opponent. The doctrine of Messrs. Darwin and Wallace, as advocated by the late Prof. Huxley, was held by me from 1860 onwards for several years. There was no antecedent reason why it should be unwelcome to me, and, in fact, it was not at all so. It was whilst working at Lemuroids that doubts first suggested themselves, which afterwards became, for me, certainties.

It is one of those animals—the Potto—which has a specific character, the least likely of any that I know of to have been produced by "natural" or "sexual" selection—one which I cannot believe was ever occasioned by "utility," though it may have been so by another now suggested cause. It appears to me to be an indisputable fact that in certain groups of animals there are, somehow, present, innate tendencies to development along certain lines; different degrees of the realisation of which tendencies are characteristic of different species; and this without affecting the preservation of life. Thus amongst the Lemuroids there appears to be a tendency to diminish the size of the index finger, and this tendency culminates in the Potto.

In a section of the *Marsupialia* there seems to be a similar tendency to diminish the size of two digits of the foot, though I cannot believe that life has been saved at either the initial or the extreme stages of this progressive degradation.

Our own species supplies another example similar in character. The penial bone of the lower apes is a considerable structure, but in the Anthropoids it becomes so rudimentary, that the chimpanzee was believed to have none till the late Mr. Crisp exhibited the rudimentary representative of that structure at a meeting of the Zoological Society, as I well remember. In man it has, at least normally, entirely disappeared, and yet it is impossible to suppose that its progressive disappearance has been progressively useful as regards any form of "natural selection."

The existence of a latent tendency in a group of animals seems to us peculiarly well marked in the Birds of Paradise. The exceptional abnormalities of their plumage are so different in different species, that these could never have sprang from a common origin, but must have independently arisen in different modes in different species.[1]

Dr. Wallace said: "Accessory plumes and other ornaments originate at points of great nervous and muscular excitation." But the points of origin of abnormalities of plumage in these birds are so numerous and diverse, that such local excitations seem a very inadequate cause to account for them. Yet even if they were adequate, what would account for such varied localities of excitation in this particular group of birds alone?

But Dr. Wallace affirmed that such characters were utilised "for purposes of recognition," . . . "each ornament being really a 'recognition mark,' and therefore essential to both the first production and subsequent well-being of every species."

Let us suppose that a certain group of birds (A) have begun to vary in such a way that the males have acquired incipient secondary sexual markings or growths in their plumage, and that another group of birds (B) have begun to vary so that new tints, or plumage growths, appear equally in both sexes. The change must be small at first, and, indeed, Dr. Wallace said "the transition" is an "almost imperceptible process." But what influence can, at the same time, induce the males of the group (A) to seek for females newly modified but different from themselves, and the males of the group (B) to seek for females newly modified but like themselves? Why should the slightly modified new varieties object to mate with members of the hardly different parent stock? Yet if they did not so object in a majority of cases the new variety would soon disappear. Dr. Wallace told us that such marks must have been specially needed during the earlier stages of differentiation, yet at such early stages the much-needed "recognition marks" must have been at their minimum. This innate spontaneous impulse to breed together, thus supposed to arise in members of every incipient new variety whence every new species has arisen, is surely a very mysterious impulse. No doubt Dr. Wallace has evidence that it does in fact exist; but if so, we must admit that somehow a quasi voluntary process—a psychical character—has been pre-caused (if we must not say pre-ordained), which is a *sine qua*

[1] I called attention to this fact in my "Genesis of Species" in 1870. Since then the discovery of new species with new abnormalities has intensified the force of the argument.

non for the origin of new species, but the origin of which character is as mysterious as the origin of a species itself!

Dr. Wallace affirmed that "no other agency" than "natural selection" has been shown as a probable cause of specific characters—and therefore of species. Possibly not. But if an asserted cause (X) has been shown to be incapable of producing a certain effect, it is no use to say: "It must be (X) because you cannot bring forward any definite (not X) as efficient to produce that effect." Surely it is enough to reply: "The cause you assert is insufficient, and we must therefore still remain in an attitude of doubt and expectancy."

Dr. Wallace, however, in his recent paper did admit that the distinctive characters of some exceptional species might not have been due to "utility" or "natural selection"; but such an admission seems to me a fatal one, for if an unknown cause may have given origin to some species, why may not such cause have been the really efficient agent in the production of all species?

But Dr. Wallace years ago made (and he has never since repudiated his act) a truly important exception to the action of "natural selection."

A survey of the organic world cannot certainly be a scientific one if the highest of animals (man) be left out of the account, nor can man be said to be scientifically treated if his highest characteristics be altogether neglected.

Dr. Wallace cannot be accused of such neglect, and therefore with a survey of the organic world thus scientifically defective. Taking account of man's highest intellectual powers, he has declared that "natural selection" must have been incompetent to produce them, and agreed with me in the conviction that they require some further and higher explanation.

A recent number of NATURE has contained a review of Prof. Weismann's paper read at Leyden. Therein, that ardent Darwinian appears to have made several notable concessions which bear upon the question treated by Dr. Wallace. One of these is that "mimicry" cannot be accounted for by accidental, individual variation; he appears to say the same concerning certain co-adjustments of instinct and structure, and he fully concedes the truth asserted by Mr. Herbert Spencer and by myself—the truth, namely, that *panmixia* cannot explain the annihilation of rudimentary organs.

He, however, reaffirms his dictum that the idea of "teleological contrivances is inadmissible in science." But why? Who can deny to reason its right to investigate truth on all sides, and affirm that which appears to be evidently true with respect to any, including vital, processes? I adhere to the pronouncement of the world-renowned John Müller: "Physiology is no true science if not in intimate union with philosophy." Once more I must urge that man and his highest intellectual powers cannot be excluded from a scheme of nature which is truly scientific. Man has intelligence, and acts more or less frequently with intelligent purpose—"teleological contrivance"—and he exists in a universe which, as a whole, can never have been submitted to the action of "natural selection." The universe, therefore, even if eternal, cannot have unreason for its cause, or any power devoid of intelligence and purpose.

I believe the indisposition to accept such truths as a part of science is largely due to our common tendency to permit the intellect to be fettered by the imagination, thus giving rise to anthropomorphic mental images, the absurdity of which is assumed also to belong to those intellectual conceptions with which they have infinitely less to do than have the signs of the zodiac with the coherence of the solar system.

Saltburn-by-the-Sea, June 29. ST. GEORGE MIVART.

"The Reminiscences of a Yorkshire Naturalist."

WHEN reading this very interesting record of my old friend and colleague (of which you gave such an excellent review in your issue of June 25), I found that, in his recollections of the days when we were both professors at the Owens College, Manchester, Dr. Williamson has been mistaken as to the details of Principal Scott's retirement. Mr. J. Holme Nicholson (late Registrar of this College) confirms my memory as to dates, and, at Mrs. Williamson's request, I ask you to kindly insert, in your forthcoming number, the following correction in her late husband's graphic account of the early struggles through which Owens College had to pass on the way to its present high position as an institution for sound instruction in natural science and original research.

At page 140 of the "Reminiscences," there occurs the following passage: "Dr. Scott's resignation (May 28, 1857) robbed Manchester of a man of rare culture, and his death a few months later is said to have taken from the world more Dantesque learning than was left behind." There are two errors in this passage: in the first place, Dr. Scott did not sever his connection with Owens College in 1857; he resigned his principalship, but not his chairs of Logic, Moral and Mental Philosophy, and of Comparative Grammar and English Language and Literature, which he continued to hold until his death. Secondly, he died on January 12, 1866, and therefore not *a few months*, but *nearly nine years* after his resignation of the principalship. Consequently, it is a mistake to infer that Manchester was robbed of his presence and the advantages of his learning in 1857.

This correction is the more important because Dr. Williamson's words, above quoted, and their context, seem to convey, I am sure quite unintentionally, the impression that Dr. Scott's death was hastened by his resignation of the principalship; whilst, on the contrary, his relief from one of his many arduous duties probably prolonged his interesting and valuable life.

E. FRANKLAND.

The Tsetse Fly.

IN the excellent review of the Tsetse fly-disease, which appeared in NATURE of April 16, Mr. Walter F. H. Blandford accepts with some reserve the observation made by Dr. David Bruce, that the fly is *viviparous* "as the fly has not yet been bred from the puparium."

I pointed out to Dr. Bruce, while he was investigating the disease, that, with the systematic arrangement of Diptera now followed, I could hardly conceive the *Glossina* being viviparous; and I suggested the possibility of another fly being taken for the Tsetse. Dr. Bruce has not only been most emphatic in his reassertion, but I have myself since bred from three puparia, sent by him for that purpose, what is most certainly *Glossina morsitans*, Westwood. L. PÉRINGUEY.

South African Museum, Cape Town, June 15.

MY hesitation in accepting unreservedly Dr. Bruce's account of the reproduction of *Glossina* was due to a suspicion, not that he had mistaken some other fly for it, but that the extruded larvæ might turn out to be those of a parasitic form, probably Tachinid. Mr. Péringuey's letter is most welcome as supplying the final proof of an extremely important fact, both economically and zoologically, in the insect's life-history.

There is much variety in the larval life of *Muscidæ*; and in *Stomoxys*, the genus most nearly allied to *Glossina*, the larvæ are normally scatophagous, but that of *S. calcitrans* has been occasionally found mining the leaves of burdock, coltsfoot and deadly nightshade.

Unfortunately, till proof is complete that Nagana is contracted under natural conditions from Tsetse-infection only, which is as yet far from being the case, we cannot console ourselves with the idea that the progressive extinction of African wild game must soon render the disease a thing of the past.

July 6. WALTER F. H. BLANDFORD.

The Salaries of Science Demonstrators.

I SHOULD be glad if you would allow me the opportunity of endorsing Dr. Baker's protest contained in his letter in your issue of July 2, against the totally inadequate salaries offered by University Colleges to demonstrators and assistant lecturers in science.

Taking the subject of chemistry only: on looking over the official returns for the year 1893-4, made by eight of the University Colleges participating in the Treasury grant of £15,000, it will be seen that whereas the average salary paid to the professor is over £700, that of the assistant lecturers and demonstrators is under £150, and in several cases below £100 per annum.

No one acquainted with what is required of them will maintain that the professors are overpaid, but all must admit that the remuneration of the lecturers and demonstrators is absurdly out of proportion.

Compare for a moment the work done by the two classes of teachers. The occupant of a chair of Chemistry in a University

College is too often bound down by the exigencies of examinations to the delivery of certain set lecture courses, and these, together with his own researches and the performance of the many administrative duties that fall to his lot, occupy almost the whole of his time. Let him possess the master-mind of a Hofmann, his hurried visits to his laboratory afford comparatively slight opportunity for the exercise of its full effect on the student. The demonstrator, on the contrary, bears the brunt of the difficult and harassing tutorial work in his close contact with the student in the laboratory, and upon the demonstrator's ability and manner of teaching will depend, in great measure, the student's future style of work. For this a grateful University College gives him rather less than it pays to its janitor, and much less than half the amount received by its travelling dairy-maid !

I am afraid that the cause of this very real injustice will be found, in part, in the influence of our older universities, where until recently lectures were everything and practical work was naught. Members of these universities on college councils still seem to cling to the old idea, and the majority of the remaining members, probably excellent men of business or affairs, have somewhat hazy notions of scientific educational work ; the Professors, who alone of the teaching staff obtain representation on the governing body, are, after all, but human, and can scarcely be expected to labour to disabuse them.

I fear that, as a body, demonstrators and lecturers are scarcely influential enough to approach the Chancellor of the Exchequer with a view to his imposing such conditions that the renewal of the Treasury grant shall be made to depend upon the redress of their wrongs ; still the injustice of their treatment is undeniable, and perhaps some of your readers can suggest a remedy.

SAVILLE SHAW.

A Solar Halo.

SHORTLY after 7 o'clock in the evening of July 2, a solar halo was observed from Putney Bridge, West London.

The appearance consisted of portions of the inner halo (22° from the sun) situated just at the same height above the horizon as the sun. The halo was of a distinct red on the inside of the circle, followed by yellow and by a faintly bluish white light on the outside. There was also a faint parhelion on the right side, just outside of the halo.

Above the sun, at a point where the vertical through the sun would have cut the circular halo, there was, instead of the latter, an inverted arch of somewhat hyperbolic shape, the arms of the hyperbola extending upwards and enclosing an angle greater than a right angle. The faint prismatic colours of this arch were placed so that the red was nearest to the sun, and the apex of the inverted arch must have been 22° distant from the sun. The height of the sun above the horizon was estimated to be about 14°, and the phenomenon lasted ten minutes after it had been first observed. The sky was somewhat cloudy.

West Kensington. H. WARTH.

An Optical Illusion.

WHILE doing some photographic work with a light from a Welsbach burner, which shone through a small ground glass window in a dark-room, I noticed that when a lamp emitting red rays from its vertical sides was placed in a position so that its top was illuminated by the white light from the window, and while in this light it was then moved by hand to and fro in a horizontal plane, the top appeared to be loose, or displaced in opposite directions to the red sides. The top was of bright tin and its surface sufficiently irregular to cast slight shadows, which rendered the effect very marked.

This illusion is no doubt due to a physiological action at the retina, in which the impression produced by the white or grey light persists longer than that from the red, causing an apparent lag of the top. The persistency may be still further accounted for when the fact is borne in mind that the lag could only be obtained with weak lights in a dark-room, and therefore with the pupil of the eye largely expanded, and in consequence a relative increase of intensity of the white over the red light upon retinal areas of different sensibility.

Lamplight or daylight can be used instead of a Welsbach. I found it convenient to vary the intensity and colour of the lights by superposing sheets of coloured tissue-papers.

New Rochelle, N.Y. F. H. LORING.

Food of Chameleons.

I do not know whether you care to insert a modest natural history communication, for I apprehend but few of your readers are country naturalists. If you do, it is to this effect.

It is not easy to keep chameleons alive long in this country, owing to the difficulty of procuring their proper diet.

I am keeping a Madagascar one, and he thrives very well. The food he seems to prefer to all other is the common green fly with a metallic lustre ; these he takes at once in preference to the finest bluebottles, and when he protrudes his curious long tongue, armed with some glutinous matter, the direction is unerring, and woe to the fly. The chameleonic colour changes are most interesting. E. L. J. RIDSDALE.

Rottingdean.

Röntgen Rays.

MANY tubes for Röntgen ray researches have the edge of the kathode mirror opposite the short neck, and in such cases the expedient described by Mr. Porter in your issue of the 18th ultimo, can very easily be carried out by fitting an india-rubber ring on this neck, winding two coils of copper wire round it, and leaving two or three inches free at one end, which is then bent so as to bring the point sufficiently near to the kathode loop.

An application of the Röntgen rays has been made in the small local museum here, which promises to make it more generally attractive and useful. Skiagrams of suitable specimens have been taken, and prints from these placed alongside the specimens, so that their external form and the bony structure which supports it may be compared at a glance.

Keith, N.B., July 3. ALEX. THURBURN.

A Curious Connection.

IF new, perhaps the following fact, observed by me, may be worth publishing. In my kitchen I have a mantle on the gas-burner. At present the mantle is in a dilapidated state, and the light defective. I find, however, that, when the water-tap over the kitchen sink is running, the light greatly increases in brilliancy, maintaining that brilliancy as long as the water is running. MARGARET MCEVOY.

THE INTERNATIONAL CATALOGUE CONFERENCE.

THE International Conference organised by the Royal Society to consider the preparation and publication of an International Catalogue of Scientific Literature was opened in the apartments of the Society at Burlington House on Tuesday. Upon the importance of such a catalogue it is unnecessary to comment here. The Royal Society has steadily attacked the problem of recording and indexing scientific literature, since the middle of this century, when the great author-index was commenced. More than thirty years ago the Council of the Society resolved that the catalogue according to authors should be followed by an index according to subjects, and a start was made in 1893. But, as Lord Kelvin pointed out in his last anniversary address, "the continuation of such a work was almost beyond the resources of the Royal Society, and therefore about two years ago a Committee was appointed to take into consideration a suggestion that the preparation of complete indexes should be effected by international co-operation." The conference now being held is the outcome of this conclusion. Only by securing international co-operation could such a work as that contemplated by the Royal Society be satisfactorily carried out. It is therefore a matter of extreme congratulation that the proposal has been so warmly supported by Governments and Scientific Societies in all parts of the world, as shown by the distinguished men who have been delegated to take part in the conference. The enterprise is one in which all men of science are interested, but of the magnitude of which it is only possible to have a faint conception. To develop a comprehensive and practicable scheme will be a difficult task, but with a conference constituted like that now

sitting the work will be well considered, and we may confidently expect as a result the outlines of a system which will have international confidence and support.

From the following list of delegates to the Conference it will be seen that nearly all the Governments of civilised countries are represented, and most of the leading scientific societies of the world.

The delegates in attendance are:—AUSTRIA—Prof. Ernest Mach (Member of the Kaiserliche Akademie der Wissenschaften, Vienna); Prof. Edmund Weiss (Member of the Kaiserliche Akademie der Wissenschaften, Vienna). BELGIUM—M. H. La Fontaine (Membre, Institut International de Bibliographie, Brussels); M. Paul Otlet (Membre de l'Institut International de Bibliographie); M. de Wulf (Membre de l'Institut International de Bibliographie). DENMARK — Prof. Christiansen (Universitet, Copenhagen). FRANCE—Prof. G. Darboux (Membre de l'Institut de France); Dr. J. Deniker (Librarian, Muséum d'Histoire Naturelle, Paris). GERMANY—Prof. Schwalbe (Berlin); Prof. Dziatzko (Göttingen); Prof. Walther Dyck (Mitglied der K. Bay. Akad. der Wiss. zu München); Prof. Van't Hoff (Mitglied der K. P. Akademie der Wissenschaften zu Berlin); Prof. Möbius (Mitglied der K. P. Akademie der Wissenschaften zu Berlin). GREECE—M. Avierinos M. Averoff (Greek Consul at Edinburgh). HUNGARY—Prof. August Heller (Librarian, Ungarische Akademie, Buda-Pesth); Dr. Theodore Duka (Membre, Academie Hongroise des Sciences, Buda-Pesth). ITALY—General Annibale Ferrero (Italian Ambassador in London). JAPAN—Assistant Professor Hantaro Nagaoka (University, Tokio); Assistant Professor Gakutaro Osawa (Medical College, Tokio). MEXICO—Señor Don Francisco del Paso y Troncoso. NETHERLANDS—Prof. D. J. Korteweg (Universiteit, Amsterdam). NORWAY—Dr. Jörgen Brunchorst (Secretary, Bergen Museum). SWEDEN—Dr. E. W. Dahlgren (Librarian, Kongl. Svenska Vetenskaps Akademie, Stockholm). SWITZERLAND—M. C. D. Bourcart (Swiss Minister in London); Prof. Dr. F. A. Forel (Président du Comité Central de la Société Helvétique des Sciences Naturelles). UNITED KINGDOM — Representing the Government: Right Hon. Sir John E. Gorst, Q.C., M.P. (Vice President of the Committee of Council on Education). Representing the Royal Society of London: Prof. Michael Foster (Sec. R.S.); Prof. H. E. Armstrong, F.R.S.; Prof. Liversidge, F.R.S; Mr. J. Norman Lockyer, C.B., F.R.S.; Dr. Ludwig Mond, F.R.S.; Prof. A. W. Rücker, F.R.S. UNITED STATES—Dr. John S. Billings (U.S. Army); Prof. Simon Newcomb, For. Mem. R.S. (U.S. Nautical Almanac Office). CANADA—The Hon. Sir Donald A. Smith, G.C.M.G. (High Commissioner for Canada); CAPE COLONY—Mr. Roland Trimen, F.R.S.; Dr. David Gill, F.R.S. INDIA—Lieut.-General Richard Strachey, R.E., F.R.S. NATAL—Walter Peace, Esq., C.M.G. (the Agent-General for Natal). NEW SOUTH WALES—(Awaits confirmation). NEW ZEALAND—The Hon. W. P. Reeves (Agent-General for New Zealand). QUEENSLAND—The Acting Agent-General for Queensland.

Subjoined is the official report of the preliminary proceedings on Tuesday.

Prof. Foster (Sec. R.S.) moved that Sir J. Gorst act as provisional President for the purpose of organising the Conference.

The resolution, having been unanimously accepted, Sir John Gorst welcomed the delegates.

Prof. Armstrong gave a brief account of the work done by the Royal Society in arranging for the conference, as well as of the work to be accomplished.

The following resolutions were then agreed to.

(*a*) That each delegate shall have a vote in deciding all questions brought before the Conference.

Que chaque délégué aura un vote pour décider toutes les questions soumises à la Conférence.

Dass jeder Delegirte eine Stimme haben soll bei Entscheidung aller Fragen die vor die Conferenz gebracht werden.

(*b*) That English, French and German be the official languages of the Conference, but that it shall be open for any delegate to address the Conference in any other language, provided that he supplies for the *procès verbal* of the Conference a written translation of his remarks into one or other of the official languages.

Que l'Anglais, le Français, et l'Allemand seront les langues officielles de la Conférence, mais que chaque délégué pourra s'adresser à la Conférence dans n'importe quelle autre langue, pourvu qu'il remettra pour le procès verbal de la Conférence une traduction écrite de ses observations dans l'une des langues officielles.

Dass Englisch, Französisch und Deutsch die offiziellen Sprachen der Conferenz sein sollen, dass es aber jedem Delegirten freistehen soll, bei die Conferenz in einer andern Sprache zu sprechen, vorausgesetzt, dass er für das Protocoll der Conferenz eine schriftliche Uebersetzung seiner Rede in einer der offiziellen Sprachen liefert.

General Ferrero moved that Sir John E. Gorst be the President of the Conference. The motion having been unanimously accepted,

Sir John Gorst nominated as Vice-Presidents: General Ferrero, Prof. Darboux, Prof. Mach, Prof. Möbius, and Prof. Newcomb.

It was further resolved—

(*c*) That Prof. Armstrong be the Secretary for the English language; that Prof. Forel be the Secretary for the French language; and that Prof. Dyck be the Secretary for the German language.

(*d*) That the Secretaries, with the help of shorthand reporters, be responsible for the *procès verbaux* of the proceedings of the Conference in their respective languages.

The President and Council of the Royal Society gave a reception to the delegates on Monday; and on Tuesday evening the delegates were entertained at a banquet at the Hôtel Métropole. The chair was taken by the President, Sir Joseph Lister, and there were also present Sir F. Abel, Agent General for British Columbia, Agent-General for Cape of Good Hope, Agent-General for Natal, Agent-General for New South Wales, Agent-General for New Zealand, Agent-General (acting) for Queensland, Agent-General for Western Australia, Prof. Armstrong, M. Averoff, Prof. Ayrton, Prof. Barker, Belgian Minister, Mr. Bidder, Dr. J. Billings, Sir F. Bramwell, Mr. H. Brown, Dr. Brunchorst, Dr. Brunton, Mr. Burbury, Dr. Champneys, Prof. Christiansen, Mr. Clough, Dr. Dahlgren, Prof. Darboux, Dr. Deniker, M. De Wulf, Dr. T. Duka, Prof. Dyck, Prof. Dziatzko, Dr. Elgar, Mr. C. E. Fagan, Dr. Fick, Mr. Fletcher, Sir W. H. Flower, Prof. Forel, Prof. Forsyth, Prof. M. Foster, Dr. Frankland, Sir D. Galton, Sir Robert Giffen, Dr. Gill, Dr. Gladstone, Sir John Gorst, Greek Chargé d'Affaires, Prof. Greenhill, Mr. Harrison, Prof. Heller, High Commissioner for Canada, Italian Ambassador, Japanese Minister, Prof. J. V. Jones, Mr. Keltie, Lord Kelvin, Mr. Kempe, Prof. Kennedy, Prof. Korteweg, M. La Fontaine, Prof. Lapworth, Prof. Liversidge, Mr. Lockyer, Mr. MacAlister, Mr. McClean, Prof. Mach, Mr. Mackey, Prof. McLeod, Major MacMahon, Mexican Minister, Dr. Mill, Prof. Möbius, Dr. Mond, Mr. R. L. Mond, Dr. Mott, Mr. Moulton, Prof. Nagaoka, Dr. Neale, Prof. S. Newcomb, Prof. Osawa, M. Otlet, Senor Don Paso y Troncoso, Prof. Perry, Portuguese Minister, Prof. Poulton, Mr. Preece, Pres. Soc. Chem. Industry, Lord Rayleigh, Prof. Roberts-Austen, Prof. Rücker, Mr. H. Saunders, Herr Schwalbe, Dr. Sclater, Prof. Sherrington, Prof. Sprengel, Sir Gabriel Stokes, Swedish and Norwegian Minister, Swiss Minister, Capt. Swithinbank, Rev. S. Thompson-Yates, Mr. Spencer

B. Todd, Treasurer Roy. Soc., Mr. R. Trimen, Prof. Unwin, Prof. Van't Hoff, Gen. Walker, Prof. Weiss, Mr. C. Welch, Dr. Wynne.

Sir Joseph Lister, in giving the toast of "Science in all Lands," remarked that it would be impertinent in such company to dwell on the advantages which science conferred upon humanity or upon the pleasures which she gave to those who had the privilege of cultivating her various branches. They were agreed that if the mighty project upon which the conference had met was brought to a successful issue it would very greatly promote the advance of science.

The toast was responded to by the Italian Ambassador (General Ferrero), who said that England had always taken a leading, sometimes the first, place in science from the days of Newton to those of Lord Kelvin, and the Royal Society had worthily represented the nation in its work for the advancement of science.

Prof. Mach also responded, remarking that men of science recognised no distinction of race or nationality, and they were all glad to co-operate with Englishmen in a work in which all men of science were interested, especially as the work was done under the auspices of the Royal Society.

Dr. Billings proposed "Success to the Conference and the Catalogue" in a humorous speech. He suspected that classification began in the Ark. Science was now getting so large and various that the projected summary would be of extreme value; but he did not quite know to what it would lead. If their object in carrying out this catalogue were achieved, they might anticipate a time when men and things and thoughts also would be catalogued. They might look forward down the vista of years to the time when a stranger in Hyde Park would see a passer-by with such a number as 26·053, and would then at once appreciate his status in every respect, and when the novelist would proudly show that his heroine had twenty-six points in her character, while a rival writer had only achieved nineteen.

Prof. Darboux, Prof. Möbius, and Prof. Forel briefly acknowledged the toast.

The Treasurer of the Royal Society (Sir John Evans) proposed "The Guests," and expressed the hope that the deliberations of the conference would be ultimately successful.

Sir Donald Smith, High Commissioner for Canada, responded.

The Belgian Minister proposed "The Royal Society," which he said, was the mother and model of all similar societies in Europe, and was based on the principle that science knew nothing of nationality. The president was a great master of antiseptic surgery; if he could only introduce the principles by which he was so distinguished into the realm of politics and international relations he would be one of the greatest benefactors of the human race.

The President, in response, said the society was proud to take the lead in so important a work as that of the Conference. It had given him personally much satisfaction to learn that the Conference on the first day had been exceedingly successful, and there was no doubt that if this movement was carried out, as they hoped it would be, it would prove of great help to science in all its branches.

ON THE MOTION OF A HETEROGENEOUS LIQUID, COMMENCING FROM REST WITH A GIVEN MOTION OF ITS BOUNDARY.[1]

I USE the word "liquid" for brevity to denote an incompressible fluid, viscid or inviscid, but inviscid unless the contrary is expressly stated. A finite portion of liquid, viscid or inviscid, being given at rest, within a bounding vessel of any shape, whether simply or multiply continuous; let any motion be *suddenly* produced in some part of the boundary, or throughout the boundary, subject only to the enforced condition of unchanging volume. Every particle of the liquid will instantaneously commence moving with the determinate velocity and in the determinate direction, such that the kinetic energy of the whole is less than that of any other motion which the liquid could have with the given motion of its boundary.[1] This proposition is true also for an incompressible elastic solid, manifestly; (and for the ideal "ether" of *Proc. R.S.E.*, March 7, 1890; and Art. xcix. vol. iii. of my Collected Mathematical and Physical Papers). The truth of the proposition for the case of a viscous liquid is very important in practical hydraulics. As an example of its application to inviscid and viscous fluid and to elastic solid consider an elastic jelly standing in an open rigid mould, and equal bulks of water and of an inviscid liquid in two vessels equal and similar to it. Give equal sudden motions to the three containing vessels: the instantaneous motions of the three contained substances will be the same. Take, as a particular case, a figure of revolution with its axis vertical for the containing vessel and let the given motion be rotation round this axis suddenly commenced and afterwards maintained with uniform angular velocity. The initial kinetic energy will be zero for each of the three substances. The inviscid liquid will remain for ever at rest; the water will acquire motion according to the Fourier law of diffusion of which we know something for this case by observation of the result of giving an approximately uniform angular motion round the vertical axis to a cup of tea initially at rest. The jelly will acquire laminar wave motion proceeding inwards from the boundary. But in the present communication we confine our attention to the case of inviscid liquid.

The now well-known solution[2] of the minimum problem thus presented, when the bounding surface is simply continuous, is, simply: that the initial motion of the liquid is irrotational. That the *initial* motion *must be irrotational*[3] is indeed obvious, when we consider that the impulsive pressure by which any portion of the liquid is set in motion is everywhere perpendicular to the interface between it and the contiguous matter around it, and therefore the initial moment of momentum round any diameter of every spherical portion, large or small, is zero. But that irrotationality of the motion of every spherical portion of the liquid suffices to determine the motion within a simply continuous boundary having any stated motion, is not obvious without mathematical investigation.

Whether the boundary is simply continuous, or multiply continuous, irrotationality suffices to determine the motion produced, as we now suppose it to be produced, from rest by a given motion of the boundary.

Now in a homogeneous liquid acted on by no bodily force, or only by such force (gravity, for example) as could not move it when its boundary is fixed, the motion started from rest by any movement of the boundary remains always irrotational, as we know from elementary hydrokinetics. Hence, if at any time the boundary is suddenly or gradually brought to rest, the motion of every particle of the liquid is brought to rest at the same instant. But it is not so with a heterogeneous liquid. Of the following conclusions Nos. (1), (2), (3) need no proof. To prove

[1] Read at the Royal Society of Edinburgh, by Lord Kelvin, on April 6.

[1] *Cambridge and Dublin Mathematical Journal*, February 1849. This is only a particular case of a general kinetic theorem for any material system whatever, communicated to the Royal Society, Edinburgh, April 6, 1863, without proof (*Proceedings*, 1862-63, p. 114), and proved in Thomson and Tait's "Natural Philosophy," sec. 317, with several examples. Mutual forces between the containing vessel and the liquid or elastic solid, such as are called into play by viscosity, elasticity, hesivity (or resistance to sliding between solid and solid), cannot modify the conclusion, and do not enter into the equations used in the demonstration.

[2] Thomson and Tait's "Natural Philosophy," sec. 312.

[3] That is to say, motion such that the moment of momentum of every spherical portion, large or small, is zero round every diameter.

No. 4 remark that as long as there is any motion of the heterogeneous liquid within the imperfectly elastic vessel the liquid must be losing energy; and the energy cannot become infinitely small with any finite spherical portion of the liquid homogeneous.

(1) The initial motion of a heterogeneous liquid is irrotational only at the first instant after being *quite suddenly* started from rest by motion of its boundary. Whatever motion be subsequently given to the boundary the motion of the liquid is never again irrotational. Hence

(2) If the boundary be suddenly brought to rest at any time, the liquid, unless homogeneous throughout, is not thereby brought to rest; and it would go on for ever with undiminished energy if the liquid were perfectly inviscid and the boundary absolutely fixed. The ultimate condition of the liquid, if there is no *positive* surface tension in the interfaces between heterogeneous portions, is an infinitely fine mixture of the heterogeneous parts.[1] And, if there were no gravity or other bodily force acting on the liquid, the density would ultimately become uniform throughout. Take, for example, a corked bottle half full of water or other liquid with air above it given at rest. Move the bottle and bring it to rest again: the liquid will remain shaking for some time. An ordinary non-scientific person will scarcely thank us for this result of our mathematical theory. But, when we tell him that if air and the liquid were both perfectly fluid (that is to say perfectly free from viscosity), the well-known shaking of the liquid surface would, after a little time, give rise to spherules tossed up from the main body of the liquid; and that the shaking of the liquid, left to itself in the bottle supposed perfectly rigid, will end in spindrift of spherules which would be infinitely fine if the capillary tension of the interface between liquid and air were infinitely small, he may be incredulous unless he tends to have faith in all assertions made in the name of science.

(3) If the boundary is an enclosing vessel of any real material (and therefore neither perfectly rigid nor perfectly elastic), and if it is laid on a table and left to itself, under the influence of gravity, the liquid, supposed perfectly inviscid, will lose energy continually by generation of heat in the containing vessel, and will come asymptotically to rest in the configuration of stable equilibrium with surfaces of equal density horizontal and increasing density downwards.

(4) With other conditions as in (3), but no gravity, the ultimate configuration of rest will be infinitely fine mixture (probably, I think of equal density throughout). Consider, for example, two homogeneous liquids of different densities filling the closed vessel, or a single homogeneous liquid not filling it. As an illustration, take a bottle half full of water, and shake it violently. Observe how you get the whole bottle full of a mixture of fine bubbles of air, nearly homogeneous throughout. Think what the result would be if there were no gravity, and if the water and air were inviscid and the bottle shaken as gently as you please; and if there were perfect vacuum in place of the air; or, if for air were substituted any liquid of density different from that of water.

[1] "Popular Lectures and Addresses," by Lord Kelvin, vol. i. pp. 19, 20, and 53, 54. See also *Philosophical Magazine*, 1887, second half-year: "On the formation of coreless vortices by the motion of a solid through an inviscid incompressible fluid"; "On the stability of steady and of periodic fluid motion"; "On maximum and minimum energy in vortex motion."

THE RETURN OF BROOKS'S COMET.

ON July 6, 1889, Mr. W. R. Brooks, of Geneva, New York, U.S.A., discovered a somewhat faint, telescopic comet at R.A. 356°, Dec. 9° south, in the southern region of Pisces. It had a short spreading tail, and was moving slowly to the E.N.E.

Observations in a few days enabled the orbit to be computed, and the small inclination (6°) intimated that the comet was probably one of short period. This proved to be the case after further observation, and the time of revolution was determined as about seven years. Otto Knopf, from three positions obtained at Mount Hamilton on July 8, at Dresden July 30, and at Vienna on August 19, deduced the period as 7·286 years. The comet was followed until January 1890, and from the whole series of observations Prof. S. C. Chandler found a period of 7·073 years, and that the orbit at aphelion approaches very closely to the orbit of the planet Jupiter. From March to July 1886, the distance of the comet and planet appears to have been less than 10,000,000 miles. The theory was suggested by Prof. Chandler that the comet may be identical with Messier-Lexell's comet of 1770; but Dr. C. L. Poor, on reinvestigating the matter, found little evidence in support of the idea.

The possible connection of the comet with that of 1770 is by no means the only interesting feature of this object. On August 1, 1889, Prof. E. E. Barnard observed that the comet was broken up into several detached fragments. It had previously been seen single, and had been submitted to pretty general observation without anything remarkable having been detected; but on the night of August 1, it appeared to have been suddenly shattered by some extraordinary forces or vicissitudes of a very mysterious character. One of the smaller fragments, together with the largest mass, remained visible for several months, moving in concentric paths, and forming a very interesting and rare telescopic spectacle.

The comet was a fairly conspicuous object in telescopes, but it was not visible to the unaided eye. Its apparent motion was very slow, for early in November its position was only seven degrees north of the place it had occupied four months before.

Dr. Poor fixed the next perihelion passage for November 4, 1896, and an ephemeris was prepared by Bauschinger for the spring and summer of 1896, as it was expected the comet might be picked up some months before its arrival at perihelion. This expectation has been fully realised, for the comet was re-discovered on the night of June 20 by M. Javelle, using the 30-inch refractor of the observatory at Nice. Its place was almost identical with that given in the ephemeris, and the re-discovery of the comet may therefore be regarded as another triumph for mathematical astronomy.

This comet should prove an extremely interesting object in regard to its physical appearance and changes of aspect. At the present time it is in Aquarius a little west of *Delta* in that constellation, and its position during the next few weeks will be nearly stationary. The ephemeris by Bauschinger is as follows:—

1896.	R.A. h. m. s.	Decl. ° ′ ″	Log. Δ	Brightness.
July 15 ...	22 39 1 ...	−18 9 53 ...	0·1124 ...	1·14
19 ...	39 58 ...	12 28 ...	0·0992 ...	1·22
23 ...	39 44 ...	16 28 ...	0·0866 ...	1·31
27 ...	39 24 ...	21 49 ...	0·0746 ...	1·40
31 ...	38 38 ...	27 52 ...	0·0633 ...	1·50
Aug. 4 ...	37 26 ...	34 44 ...	0·0529 ...	1·59
8 ...	35 50 ...	41 51 ...	0·0436 ...	1·68
12 ...	33 51 ...	48 48 ...	0·0353 ...	1·76
16 ...	22 31 34 ...	−18 55 2 ...	0·0284 ...	1·84

Thus the comet is likely to be visible throughout the present summer and ensuing autumn, for its brightness is gradually increasing, and it will remain in a favourable position all the time. Its southern declination of more than 18° is, however, rather unfortunate, as its altitude is only about 20°, so that observers will require to watch it from a position commanding a good open view of the southern sky.

W. F. DENNING.

NOTES.

DR. N. BUSCH, of Dorpat, has undertaken, at the request of the University of Dorpat and the Russian Geographical Society of St. Petersburg, a botanical investigation of the Caucasus. He proposes to visit the hitherto unexplored sources of the rivers Teberda and Maruch in Northern Caucasus.

THE Goldsmiths' Company has contributed a second donation of £1000 to the special funds of the research department of the Imperial Institute, to be applied to the extension of the laboratories and to their better equipment. The Salters' Company has established a Research Fellowship of the value of £150 per annum, in connection with the scientific department, tenable by chemists thoroughly qualified to undertake the investigation of new or little-known natural products received by the Institute from the colonies and India.

A ROYAL Commission has been appointed "to inquire and report what administrative procedures are available and would be desirable for controlling the danger to man through the use as food of the meat and milk of tuberculous animals, and what are the considerations which should govern the action of the responsible authorities in condemning for the purposes of food supplies animals, carcasses, or meat exhibiting any stage of tuberculosis." The Commissioners are Sir Herbert Maxwell, Dr. Richard Thorne Thorne, C.B. (medical officer of the Local Government Board), Mr. George Thomas Brown, C.B., Mr. Harcourt Everard Clare, Mr. Shirley Forster Murphy (member of the Royal College of Surgeons), Mr. John Speir, and Mr. Thomas Cooke Trench.

THE death is announced of Prof. E. Curtius, the distinguished Professor of Archæology in the Berlin University.

PROF. AUGUST KEKULÉ V. STRADONITZ, Professor of Chemistry in the University of Bonn, died on Monday, at the age of sixty-six.

THE Vienna Academy of Sciences announces as the subject of the Baron von Baumgartner prize of 1000 florins, "Extension of the Knowledge of the extreme Ultra-violet Rays." The prize will be awarded in 1899.

FROM a special number of their *Atti*, we learn that the Reale Accademia dei Lincei (of Rome) has made the following awards: Of two prizes given by the King of Italy, one for chemistry and the other for philosophical science, the first has been divided equally between Prof. Luigi Balbiano, of the University of Rome, for his monograph on certain compounds of the pyridine series, and Prof. Raffaele Nasini, of the University of Padua, for a series of twenty-seven papers on chemical physics. The prize for philosophy has not been awarded. Two prizes of 1500 lire, given by the Minister of Public Education, have been awarded—one for mathematics, the other for philology. For the mathematical prize eight candidates have submitted essays, and the prize has been adjudged to Prof. Geminiano Pirondini, of Parma, in consideration of eleven printed and written papers on geometry. The philological prize has been divided between Profs. Filippo Sensi, Silvio Pieri, G. B. Camozzi, Antonio Fiammazzo, and Oreste Antognoni. Of a further prize, given by Signor Enrico Santoro (an Italian residing in Constantinople), for mechanical inventions relating to weaving or spinning, the award has been postponed for a couple of years. These awards were announced at the twenty-first anniversary commemoration of the revival of the Academy on June 7, in presence of the King and Queen of Italy.

THE prize awards of the French Société d'Encouragement, for 1896, were announced at the recent annual general meeting. The Prix Giffard, for distinguished services to French industry, is of the value of 6000 francs; but this year, on account of exceptional merit, it has been increased to 10,000 francs and divided equally between D. Legat, for his mechanical works, and the family of the late A. Martin, renowned for his optical researches. The Grand Gold Medal, awarded each year to the author whose works have exercised the greatest influence on the progress of French industry in the preceding six years, was this year in the gift of the Comité des Arts mécaniques, who have voted it to F. G. Kreutzberger, the inventor of numerous improvements in machinery. M. Effront has been awarded the Prix Parmentier of 1000 francs for his works on alcoholic fermentations. The prize of 1000 francs for an oil motor has been gained by the Priestman motor. M. Lefèvre has obtained the prize of 2000 francs for a publication useful to chemical industry, by his remarkable "Traité des matières colorantes," reviewed in these columns on April 30 (vol. liii. p. 603). The Prix Melsens, for the author of an application of physics or chemistry to electricity, ballistics, or hygiene, has been awarded to Dr. Castaing for his works on ventilation. The prize of 2000 francs for an incandescent lamp of one-candle power, 100 volts, 1/20 ampere, has not been awarded, but an *encouragement* of 1000 francs has been given to MM. Javaux and Nysten, and a similar sum to M. Solignac. The prize of 2000 francs, for the best investigation on the comparative physical and chemical constitution of agricultural land in France, has also not been awarded, but 1500 francs have been granted to MM. Beuret and Brunet, and 500 francs to M. Waldmann. Grants of 1000 francs have been made to Prof. Zipcy and M. Jaffler as *encouragements* in connection with the prize of 2000 francs for pisciculture.

THE great sea-wave which accompanied the recent earthquake in Japan appears to have been even more destructive to life and property on the north-east coast than was at first reported. A dispatch received by the Japanese Legation, from Tōkyō, says:—"The loss of life and property caused by the tidal wave, which visited the north-east coast of Japan on June 15, is as follows, according to the official returns received up to the 22nd of that month. In the Prefecture of Aomori 346 lives lost, 840 houses washed away; in the Prefecture of Iwate, 23,309 lives lost, 5920 houses washed away; in the Prefecture of Miyagi, 3344 lives lost, 715 houses washed away. Besides the above, the number of persons injured is as follows: 213, 23,840, 1184 in the above Prefectures respectively."

DR. BROWN GOODE makes the following comparison in a Report of the U.S. National Museum, lately issued:—"There is not a department of the British Government to which a citizen has a right to apply for information upon a scientific question. This seems hard to believe, for I cannot think of any scientific subject regarding which a letter, if addressed to the scientific bureaus in Washington, would not receive a full and practical reply. It is estimated that not less than 20,000 such letters are received each year. The Smithsonian Institution and National Museum alone receive about 6000, and the proportion of these from the new States and Territories, which have not yet developed institutions of learning of their own, is the largest. An intelligent question from a farmer of the frontier receives as much attention as a communication from a Royal Academy of Sciences, and often takes more time for the preparation of the reply." It is little to the credit of British Governments that Dr. Goode's comparison should be so much to our disadvantage.

ACCORDING to the last report of the British Consul at the Piræus, a Pasteur Institute has been in existence in Athens for more than a year. During this period 201 cases have been treated, with only one death; in that case the patient had delayed submitting himself to treatment for fifteen days after

the infliction of the bite. The Institute was founded by Dr. Pampoukis, who studied for a time under M. Pasteur in Paris. He established the Institute at his own expense, but after a time the municipality and the Government granted him a small annual subvention. The Consul goes on to say: "It is practically impossible to over-estimate the value of such an establishment in the Levant, which is overrun with ownerless dogs. A muzzling order does exist in Attica, but it is not enforced, and the distribution of poisoned meat in the streets of Athens and the Piræus is apparently the only attempt made by the authorities to deal with an increasing amount of rabies."

IN view of the numerous applications of aluminium in the manufacture of water-bottles for military use, cooking utensils, and other articles where there is a necessity for lightness combined with resistance to corrosion, several researches on the behaviour of this metal towards liquids have been recently carried out. Mr. J. W. Richards, who has just published the latest contribution to this subject in the *Journal of the Franklin Institute*, has studied more especially how far the power of resisting the attack of corrosive liquids can be increased by alloying with small quantities of other metals. The general result of the experiments is to show that pure aluminium resists the action of alkaline solutions better than any of the alloys examined. This also holds true for solutions of nitric acid and of common salt; but an alloy containing 2 per cent. of titanium appears to be the best for liquids containing free hydrochloric acid. All the alloys tried offer great resistance to the action of acetic and carbonic acids.

MR. HENRY DEANE referred to the late Sir William Macleay's bequest for the endowment of a lectureship in bacteriology, in his presidential address to the Linnean Society of New South Wales, a copy of which has just reached us. It may be remembered that the Senate of the Sydney University decided to relinquish the bequest, and to return the money to the executors. This was done about a year ago, and the sum, amounting to £12,704, was afterwards paid into the Linnean Society of New South Wales. By the terms of the bequest, it has devolved upon the Council of the Society to invest the money, and use the interest to pay a competent bacteriologist, and maintain a suitable laboratory with appliances for bacteriological research. The result is that the Council has decided to appoint a bacteriologist at the close of the hot season 1896–97, provided that one can be engaged on what are practically the terms and emoluments offered to University demonstrators. A number of other subjects were passed in review by Mr. Deane in his address. His remarks upon forestry will perhaps do something towards checking the depletion of the forests of New South Wales.

AN important point dealt with by Mr. Deane in the address referred to in the foregoing note, is the origin of the vegetation of Australia. Prof. Ettingshausen's observations and conclusions are adversely criticised; and it is stated that at present the known facts seem to afford grounds for concluding: (1) That many, if not all, the typical Australian floral types originated in Australia or in some land connected with it, but now submerged. (2) That the assumption of the existence of a universal flora of mixed types at any epoch is unfounded. (3) That the fossil plant-remains of Tertiary age in Eastern Australia indicate a vegetation in all respects similar to that existing on the coast in the same latitude at the present day. To these Mr. Deane thinks may be added a fourth conclusion of less certain character, but of high probability, that the *Proteaceæ* represent a most ancient type which had their origin at a time when not only extensive areas of land existed in the southern hemisphere, but when some kind of connection, more or less lasting, existed between Australia and South Africa. Mr. Deane concluded his address with an account of the work of the Horn expedition to Central Australia.

MUCH attention has been paid in recent years to the prediction of the minimum night temperature, on account of its importance to agriculture, especially in spring-time, when late frosts are detrimental to delicate plants, and various important papers have been written upon the subject, *e.g.* by M. Kammermann, of the Geneva Observatory, and M. Lemström, of Helsingfors. Reference to the matter may also be found in some text-books of meteorology, where it is pointed out that if the dew-point is determined in the evening, it will rarely be found that the air temperature will fall much below that point during the night. In the current number of *Ciel et Terre*, M. Lancaster draws attention to the fact, which, if known, is not generally acknowledged, that as long ago as 1824 this relation between the night minimum and the temperature of the dew-point was indicated by Dr. A. Anderson, in a note entitled "On the influence of the hygrometric state of the atmosphere upon the minimum temperature of the night," printed in vol. xi. pp. 161–9 of the *Edinburgh Philosophical Journal*. The same author also refers incidentally to the subject in a short note "On the Dew-point," presented to the British Association in 1840. As M. Lancaster says, this is one of many instances presented by the history of science, of problems being studied, which have been long since solved.

THE Council of the Scottish Meteorological Society presented their report at the annual general meeting held yesterday. From the report we learn that a large work, which has been in course of preparation for some time, has just been completed, viz. averages of mean temperature and mean barometric pressure for the forty years ending with December 1895 have been calculated for each of the Society's 145 stations. It is not possible to over-estimate the importance of these averages in carrying on several of the more important departments of the Society's work, more particularly in the preparation of the monthly and quarterly report of Scottish weather. The very heavy work of recopying, on daily sheets, the hourly observations of the two Ben Nevis Observatories has now been virtually completed down to date. This result has been mainly secured by the aid of the grant of £100 obtained from the Government Research Fund last year. The large inquiry carried on by Dr. Buchan and Mr. Omond for some years on the influence of fog, cloud, and clear weather respectively, on the diurnal fluctuations of the barometer, has been extended into other regions, particularly the Arctic regions and Portugal, which furnish data of the utmost importance to the inquiry. Among the questions more immediately raised, as the investigation proceeds, is the influence on the pressure at the two observatories of the vertical distribution of temperature and humidity through the intervening stratum of air between the top and bottom of the mountain. The Council referred to the handsome donation of £1875 made to the Ben Nevis Observatories by the Trustees of the late Earl of Moray; they have by means of it been enabled to engage an additional clerk for the office, so that, for the next two or three years, Dr. Buchan's time may be largely set apart for the discussion of the Ben Nevis observations. It has further been resolved to establish a temporary station during the summer and autumn on the top of Meal ant' Suie, situated at a height of 2322 feet, and in the line of the two observatories. The object sought to be attained by this new station is a better knowledge of the vertical distribution, particularly during anticyclonic periods, of temperature and humidity through the aërial stratum between Fort-William and the top of Ben Nevis.

THE meteorological department of the library of Harvard College Observatory has become, by recent large accessions, one of the most complete collections of meteorological works in the United States. In the early history of the Observatory, many such works were collected by the first and second directors of the institution, Profs. W. C. Bond and G. P. Bond; and since

then the collection has continued steadily to increase. More recently, states the Harvard College Observatory *Circular*, No. 8, three large additions have been made to it: the general library of Harvard University has placed at the Observatory a great number of the meteorological works formerly kept at Gore Hall; the Blue Hill Meteorological Observatory has made a similar transfer; and the New England Meteorological Society, which has lately dissolved its organisation, has deposited the works contained in its library, and also the remaining copies of its own publications. Special efforts are now in progress to render still more complete the large collection which has resulted from these additions. It is hoped that the meteorological department of the library may be made so complete as greatly to increase its present value in aiding the studies of meteorologists.

IN spite of its limited resources, the British School at Athens contrives to initiate and carry out very valuable archæological work. The report read at the annual eeting of the supporters of the school, held on Monday, gave an encouraging account of the work of exploration and excavation accomplished during the past year. The financial position of the school, though still below that of its rivals, is now upon a footing which is comaratively satisfactory. The subscriptions, together with the Government grant of £500 per annum for five years, lead the Committee to believe that they may reckon upon an annual income of £1400 for some years to come. Of this it is estimated that about £1000 will be required for the current expenses of the school (including studentships), leaving about £400 per annum for excavations. But though the school stands in a better financial position than it has ever been before, its revenue is still modest as compared, for example, with the £3100 a year of the French school, which has, in addition, received a special grant of £30,000; the £2400 of the Germans, to whom also the Government has made the contribution of £40,000 for the excavations at Olympia; and the United States school, which enjoys £2000 a year. The school is, however, doing its best on its modest resources, and the archæological discoveries made in connection with it are valuable contributions to human knowledge.

PROF. H. A. NEWTON has been making a comparison between the mortalities of Yale graduates in the years 1701–1744 and 1745–1762, to see whether the changes of mode of living and comforts had any effect upon the vital statistics of the two groups of men (Yale, *Biographies and Annals*). By arranging the mortalities in decades of years from 15 to 75 years of age in the case of each group, it was seen that the group 1745–1762 showed a distinct increase of mortality per thousand lives between the ages of 15 and 35; an equality of mortality during the next ten years, and a decided diminution for the ages 46 to 75, when compared with corresponding periods in the group 1701–1744. It is a marked feature of the mortality statistics of American college graduates that there is excessive mortality in the years immediately following graduation. This, Prof. Newton thinks, is no doubt due to the strenuous efforts of young graduates to attain a good position in their profession. The later favourable experience in the ages from 45 to 75 is presumably due to the fact that they have by that time gained position, or else lost ambition. It would seem that this early strain was experienced by the graduates of the years 1701–1744 distinctly less than it was by the graduates of the eighteen years following. It would also seem that the corresponding strain for men between the ages 45 and 75 was much greater than for the later graduates, and perhaps that there had been a decided gain in the modes and comforts of life during the quarter of a century, which on an average separates the two groups of men.

THE literature of water-bacteriology is fast assuming well-nigh unwieldy proportions; almost the latest contribution to hand is an elaborate memoir in Spanish, from the Municipal Chemical Laboratory of Valparaiso, on an epidemic of typhoid fever in this city. Dr. Mourgues, who is responsible for the report in question, claims to have successfully tracked this serious outbreak to the water supplying the city. The chemical analyses already showed it to be badly polluted with sewage; and in this condition, without undergoing filtration, it was distributed for dietetic purposes. By resorting to all the most efficient methods at present at our disposal for the discovery of the typhoid bacillus in water, Dr. Mourgues tells us that he "discovered a bacillus which, according to the majority of the bacteriologists, is the cause of typhoid fever." He exhibits, however, some degree of caution in accepting his own conclusions, for he tells us that if it was not the typhoid bacillus, it was the *B. coli communis*, which, according to Rodet, G. Roux, and Vallet, is also capable of inducing typhoid fever. Dr. Mourgues has produced an able and interesting report quite apart from the credit attaching to his investigations; for he has brought together, in a brief and handy form, most of the principal work which has been done in recent years on the bacteriology of water in relation to the typhoid bacillus.

IN a letter communicated to the *Comptes rendus* (June 22), M. Moureaux gives a short account of some recent measurements of the magnetic elements which he has made in South Russia. In the neighbourhood of a village called Kotchetovka, at latitude 51° and longitude 6° 8′ east of Poulkowa, the extreme values of the elements determined in fifteen different stations, scattered over an area of about a square kilometre, were as follows:—

Declination	+58°	to	−43°
Dip	79°	to	48°
Horizontal force	0·166	to	0·589

In addition to the extreme largeness of these differences, it is interesting to note that the horizontal force attains in this region a greater value than that found at the equator. Since the dip is not less than 48°, it follows that the value of the total force in some parts of this region is extremely large. At another village (Potrovshojé), about fifteen kilometres to the south of the first, the values of the elements were:—Declination, +52° 56′; dip, 81° 45′; horizontal force, 0·09. A series of measurements showed that the dip attained a maximum value of 82° 13′ near this point, the value of the horizontal force corresponding to this maximum being 0·079.

THE Metopic Suture is the name given by anthropologists to the persistence of the frontal suture. Several investigators have attacked the problem of the significance of this suture, but the most thorough study is that by Dr. G. Papillault in the current number (tome ii. 3 sér. 1 fasc.) of the *Mémoires de la Soc. d'Anth. de Paris*. After a very detailed investigation, the author comes to the following general conclusions:—It has no sexual significance. The brain is the primary cause of metopism; not that metopics have an intellectual superiority over other people, but a superiority in the relative weight of their brain. There is a preponderance of complicated sutures and wormian bones in metopic crania, but these are less marked in the races in which the weight of the skull increases equally with that of the skeleton; in other words, in what one generally terms the lower races. Civilisation, in multiplying and knitting the bonds of social union, in augmenting in the struggle for life the power of the intelligence and in diminishing the preponderance of brute force, permits those who are intellectually endowed to live and prosper despite their muscular weakness, and thus it also becomes one of the most important factors of metopism.

THE publication of a special journal to care for the specific interests of physical chemistry, will commence in October of this year. This *Journal of Physical Chemistry* is to be issued upon the first of every month, except that in July, August, and September no number will appear. It will contain articles embodying original research in all branches of experimental and theoretical physical chemistry; and this matter will be supplemented by reviews of the current literature of the subject. All communications concerning articles should be addressed to the *Journal of Physical Chemistry*, Ithaca, N.Y. The editors are Wilder D. Bancroft and Joseph E. Trevor, assistant professors of physical chemistry in Cornell University.

IN a recent number of the *Comptes rendus* (June 22), MM. Lortet and Genoud give an interesting account of their experiments on the effect of Röntgen rays on tuberculosis. Although still incomplete, these experiments seem to indicate that we may have in the new light a remedy for tuberculosis. Eight guinea-pigs were inoculated with the virus of tuberculosis. Three of these were exposed daily for at least an hour to the influence of powerful Röntgen radiations, from April 25 to June 18. The other five were not so treated. In the latter, abscesses were produced and the health deranged. In the three treated with Röntgen rays no abscesses were formed, the health remained good, and the animals increased in weight.

THOUGH examinations of the contents of stomachs of crows have shown that these birds feed very largely upon noxious insects and other injurious animals, the result apparently does not prove that the crow is a friend to the farmer. A note in the *North British Agriculturist* reports that much damage has been committed in turnip fields in Annandale during the past few days by crows. The crows, in their search for wire-worms, pull up the young turnips, probably finding a worm at the root of one out of 150 or 200 pulled up. The fact shows the importance of avoiding conclusions as to the usefulness of a bird merely from determination of food habits. The farmers of Annandale would probably have been better pleased if the crows had fed upon the young turnips instead of wire-worms, for the destruction would not then have been so great.

THE third part of Mr. John W. Taylor's valuable "Monograph of the Land and Freshwater Mollusca of the British Isles" has just been published by Messrs. Taylor Brothers, Leeds. It deals with the morphology and anatomy of the animal inhabitants of shells, and is illustrated just as clearly and liberally as the previous parts, in which the shells and their auxiliary appendages were described. Conchologists should be grateful to Mr. Taylor for the pains he is taking to provide them with a trustworthy and instructive work upon British Land and Freshwater Molluscs.

MESSRS. TRUSLOVE AND HANSON have in the press an illustrated work on "The Natives of Sarawak and British North Borneo," by Mr. Ling Roth. The work will be published in two volumes, and the edition will be limited to seven hundred copies. No complete work dealing with the natives of British Borneo exists, though the history of that very interesting colonial possession could furnish material for a dozen romances. How very completely Sir James Brooke, and his nephew and successor as Rajah (Sir Charles Brooke), have changed the customs of the Dyaks, should be known to all who are interested in methods of establishing British colonies, and of improving the condition of the people who inhabit them. Mr. Ling Roth's work will deal with the people of British Borneo from many points of view, and it promises to be a valuable contribution to anthropology.

THE South London Entomological and Natural History Society has sent us the abstract of the *Proceedings* for 1895, together with the address of the President, Mr. T. W. Hall. Though unpretentious in character, the Society has assisted in the diffusion of biological knowledge by its meetings and collections, and its publications always contain material of interest to every one interested in natural history. Another Society, which has just sent us its Report for 1895, is the Manchester Microscopical Society. First among the contents of this publication is an address by the President, Prof. F. E. Weiss, on "The Influence of External Conditions on Reproductive Processes in Plants." The subjects of other papers are: some insect pests, by Mr. A. T. Gillanders; the organs and function of reproduction in insects, by Mr. F. Paulden; notes on Hydrozoa and Polyzoa, by Mr. J. Smith; photo-micrography, by Mr. E. H. Turner; and the animal life of the Coal-measures, by Mr. Herbert Bolton. May such Societies as these of South London and Manchester long exist to stimulate and encourage biological and microscopical research.

WE have on our table several new editions of scientific books. First among these is the seventh edition of Dr. Benjamin Williamson's "Elementary Treatise on the Integral Calculus" (Longmans, Green, and Co.). The chapter on the calculus of variations has been considerably enlarged, and a brief discussion added on the application of that calculus to double and multiple integrals. A short chapter on the sign of substitution has also been introduced. Messrs. A. and C. Black have published the second edition of "Rheumatism: its Nature, its Pathology, and its successful Treatment," by Dr. T. J. Maclagan. Twenty years ago the author introduced salicin to the medical profession as a remedy in acute rheumatism. In the first edition of this work, published in 1881, he expounded the miasmatic theory of rheumatism, and offered an explanation of the manner in which the salicyl compounds produce anti-rheumatic effects. In the present edition the whole subject of the pathogenesis of rheumatism, and the curative action of the salicyl compounds, is gone over again. The book thus contains the history of a remarkable and beneficial change in the treatment of a disease which was the despair of a past generation of physicians. A fifth edition of a "Coloured Vade-mecum to the Alpine Flora, for the use of Tourists in Switzerland," has been published by Albert Raustein, Zürich. The book contains 170 coloured illustrations of Alpine flowers, accompanied by descriptive text in English, French, and German, by L. Schröter and Prof. C. Schröter. The book should be in the hands of every lover of Alpine flowers; and it will be found a pleasant companion to the many tourists who, during the next few months, will wander about the Alps. The pleasing and elegant "Ros Rosarum, ex Horto Poetarum," by E. V. B., the second edition of which has been published by Mr. Elliot Stock, contains a wealth of poetic extracts having the rose for their theme. The quotations show that the rose has been honoured and admired in almost all times and places. The twenty-eighth edition of "Skertchly's Physical Geography," revised by Mr. J. H. Howell, has been published by Mr. Thomas Murby. Mr. Howell has made a number of requisite alterations in the text, but the book is still badly illustrated.

THE annual Report (1894-95) of the Director of the Field Columbian Museum, Chicago, has been received. A large number of accessions to the collections have resulted from the expeditions sent out by the Museum. In October 1894, Mr. Allison V. Armour, of Chicago, invited Dr. Millspaugh, of the Department of Botany, and Prof. Holmes, of the Department of Anthropology, to accompany him on his yacht to Havana, Progreso, the islands on the east coast of Yucatan, Laguna di Terminos and Vera Cruz. On this expedition, Dr. Millspaugh's work resulted in the acquisition of nearly eight hundred speci-

mens in botany, which formed the types included in his "Flora of Yucatan," and considerable material for exchange to augment the small herbarium in his department. He also secured about four hundred specimens in zoology, principally conchology, and a number of excellent negatives relating to geology, botany, ethnology and travel. Prof. Holmes secured altogether about one thousand specimens in archæology from Yucatan, Chiapas, Oaxaca, Vera Cruz and the valley of Mexico, and made a number of important observations. An expedition to San Domingo, conducted by Mr. Geo. K. Cherrie, Assistant Curator in the Department of Ornithology, resulted in the collection of 1958 bird skins, 16 mammals, 80 reptiles, and a number of specimens of fish and Crustacea. Among the birds, two species proved new to science, and a number of others are very interesting as representing rare and little-known forms. Captain Miner W. Bruce was fitted out by the Museum for an expedition to Alaska and Siberia in June 1894, and he acquired valuable ethnological material from North Alaska. A number of minor expeditions were also organised in the interests of the Museum, and they have resulted in numerous additions to the collections in different departments, as well as the acquisition of information of great scientific value, which information is made known through the admirable series of publications issued by the Museum.

THE additions to the Zoological Society's Gardens during the past week include a Lesser White-nosed Monkey (*Cercopithecus petaurista*) from West Africa, a White-throated Monitor (*Varanus albogularis*) from South Africa, presented by Sir Gilbert Carter; a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Mr. Henry Russell; a Diana Monkey (*Cercopithecus diana*) from West Africa, presented by Mr. E. Kirby; a Striped Hyæna (*Hyæna striata*) from Arabia, presented by Mr. C. A. Osborne; a Hamster (*Cricetus frumentarius*), European, presented by Miss Hilton; three Yellow-bellied Liothrix (*Liothrix luteus*) from India, presented by Mr. Robert E. Graves; an Iceland Falcon (*Hierofalco islandus*) from Iceland, eight Horsfield's Tortoises (*Homopus horsfieldi*) from Central Asia, two Giant Toads (*Bufo marinus*) from Brazil, a Reticulated Python (*Python recticulata*) from Malacca, deposited; two Lettered Aracari (*Pteroglossus inscriptus*) from Para, a Black-necked Swan (*Cygnus nigricollis*) from Antarctic America, purchased; a Burrhel Wild Sheep (*Ovis burrhel*), two Glossy Ibisis (*Plegadis falcinellus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE CLUSTER IN COMA BERENICES.—The results of a triangulation of the more conspicuous stars in this group have been recently issued from the astronomical observatory of Yale College. This contribution to a class of observations that is now receiving much attention, has been made with the heliometer by Mr. F. L. Chase at the suggestion of Dr. Elkin. The instrument employed is the same that Dr. Elkin used in his measurements of the Pleiades group, and the method of reduction follows generally the same lines that were then adopted; but the different configuration of the fundamental stars on which the measures are based, has enabled the observer to dispense in some degree with measures of position angle, the less trustworthy coordinate in heliometer observations, and to rely upon measures of distance from six selected stars, five of which form nearly an equilateral pentagon, the sixth being approximately in the centre. Two lines of stars roughly crossing the pentagon at right angles, and extending some six degrees, have been utilised for determining the scale value. The final result is to give the coordinates of thirty-three stars (Equinox 1892·0) limited to about the 8·5 mag., below which magnitude the most satisfactory observations cannot be made with the Yale instrument. An examination of the probable errors of the measures, classified according to the magnitude of the stars, does not disclose any law dependent on brightness, so that Mr. Chase has not overstepped prudence in this respect. At the same time the position of so many well-scattered points of reference has been determined, that it should be an easy task, and one worthy of accomplishment, to derive the places of the remaining and fainter stars of the group by means of photography.

OBJECTIVE GRATINGS.—Messrs. Hall and Wadsworth describe in the June number of the *Astrophysical Journal* the results of a fairly successful application of an objective grating, constructed on the original Fraunhofer method, and attached to a 12-inch photographic object-glass, whose ratio of aperture to its focal length is as 1:18. Two screws 27 cm. long, and with 63 threads to the centimetre, were cut in two along their axes, and the half-screws mounted, parallel to each other, on the opposite sides of rectangular frames. Copper wire was wound across in the successive threads, and soldered to the screws so as to produce a grating. When applied to the telescope, photographic spectra of both the first and second order could be obtained, and cases are quoted showing the agreement of the deduced wave-length with Rowland's values. One of the difficulties experienced in the use of this form of grating arises from the wind disturbing the lines of the grating, an annoyance which, it is suggested, might be prevented by soldering light rods across the wires parallel to the half-screws. The time required for exposure with objective gratings is of course longer than with the objective prism; but against these two disadvantages is to be set the comparative small cost of construction. In the one used in the experiments at Chicago, the cost was only one-thirtieth of that of an equally large objective prism of small angle, and evidently the advantage on the side of economy increases as the aperture increases. In the case of the Yerkes telescope, it is computed that the grating would cost about the two-hundredth part of the prism of the same size.

DISTORTION OF THE EARTH'S SURFACE.—Under the title of "An Earth-bending Experiment," Prof. H. H. Turner gives a description of a series of observations undertaken at Oxford by Prof. J. Milne (*Observatory*, July). In his investigation of terrestrial disturbances in the Isle of Wight, Prof. Milne found evidence of their being due to several causes. For instance, some are due to real local earthquakes on a small scale, some owing to faint echoes of very distant earthquakes, while it appears that others may have their origin in the various states produced on the surface of the ground by meteorological causes. These last have specially attracted attention, as it is quite possible that the considerable load represented by a shower of rain or snow, or a heavy fall of dew, may be capable of bending the surface of the ground to such a degree as to affect the stability of any astronomical instruments not having very deep foundations. In looking for these effects, it might be expected that tilts due to rainfall, though irregular, would show some evidence of an *annual* periodicity, while those produced by dew would show a *diurnal* variation. To test whether any of these causes might have an appreciable disturbing effect, the University Observatory at Oxford was chosen as being particularly suitable, standing alone in a grassy park. The instruments for detecting and recording any difference of level consisted of one of Prof. Milne's horizontal pendulums and the level of the Barclay transit circle. The effect of a sudden shower was imitated by securing the services of seventy-six people, who were marched, in various degrees of compactness, up to and away from the slate slab supporting the registering apparatus. The result of these experiments was that a small depression was observed, always towards the crowd, the maximum value, however, being only 0″·5, when the load was concentrated and close to the instrument. The load employed being estimated greater than is likely ever to be produced by rain, &c., it is concluded that on that particular site at least no disturbance due to meteorological causes need be feared.

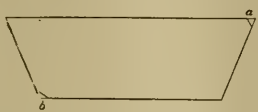
ON THE LIQUATION OF CERTAIN ALLOYS OF GOLD.[1]

THE molecular distribution of the metal in alloys of gold and of metals of the platinum group has been described by me in several papers, the most important of which has been published in the *Philosophical Transactions*. New

[1] Abridged from a paper read before the Royal Society, May 7.

interest in the subject has however arisen in connection with the extraordinary development in various parts of the world, and especially in South Africa, of certain processes which are now employed for extracting gold from its ores. Their use has been attended with the introduction into this country of a series of alloys of gold and of the base metals, which have hitherto rarely been met with in metallurgical industry. The base metals associated with the gold in these cases are usually the very ordinary ones lead and zinc; but their presence in the gold has given rise to unexpected difficulties, as the distribution of the precious metals in the ingots which now reach this country is so peculiar, that it is not possible to estimate the value of the ingots by taking the pieces of metal required for assay, by any of the well-known methods at present in use.

Investigation of the cause of the singular molecular arrangement of the ingots, has revealed many facts of scientific as well as industrial interest, which the author describes at length. The following case of an ingot of gold may be taken as typical.



Four assays were made on a portion of metal cut from the points marked *a*, at the top of the ignot; the highest of the results of assay indicated that 664 parts of gold were present in 1000 parts of the alloy, while the lowest assay gave only 465 parts. On the other hand, three assays on a piece of metal cut from the bottom of the ingot, at *b*, gave 652 parts of gold in 1000 as the highest, and 332·5 as the lowest. Clearly, therefore, the action of gravity does not explain the distribution of the precious metal.

The ordinary course, where divergent results of assay are obtained on portions of metal cut from such an ingot, would be to melt the entire mass, and take a "dip" assay piece, that is, to remove a portion of metal from the well-stirred fluid mass. This was done in all the cases cited in the paper here abridged, and as regards the mass of gold to which reference has just been made, assays on the portion of metal removed from the fluid mass gave results which were still very conflicting, the lowest assay showing the presence of 562·3 parts of gold, and the highest 653·5. It was evident therefore, that rearrangement could take place within the limits of a fragment of metal which did not weigh more than a few grammes.

The only method of ascertaining the value of the ingot consisted in separating the precious and base metals in mass, and the result of this operation showed the value of the ingot to be £1028, while the value, as calculated from the average of the assays previously made, would only have been £965, or a difference in value of £63 on an ingot weighing 12·223 kilograms. The importance of the question from an industrial point of view will at once be recognised when it is remembered that gold to the value of many millions sterling of the quality represented by the above results, now reaches this country annually.

Coming now to the scientific side of the problem, analysis of the ingot, to which reference has been made above, showed that it contained the following metals in addition to gold:

Silver	8·1	per cent.
Lead	16·4	,,
Zinc	9·5	,,
Copper	4·0	,,
Iron	·3	,,

Suspicion at once fell on the lead and zinc as disturbing elements, and their influence was systematically investigated by a lengthy series of experiments, in the course of which gold alloys, containing different proportions of gold and of impurities, were cast in spherical moulds two and three inches in diameter, the solidified masses being explored by assays made on metal representing all parts of the mass. The general result of these experiments was to show that lead exerts a greater disturbing influence than zinc. The problem was then attacked from a different point of view. I availed myself of Roberts-Austen's method of fixing the solidifying points of metals on "cooling curves" obtained by the aid of thermo-junctions connected with autographic recorders. Such curves showed that a triple alloy of lead, gold, and zinc has three "freezing points." The mass sets as a whole at a single main point of solidification, but the lead and the zinc associated with some gold retain a certain amount of individual independence, and by falling out of solution, separately destroy the uniformity of the mass, even though the mass itself be small.

After a long series of experiments, a metallic solvent which would enter into union with the gold, the zinc, and the lead was sought. Silver proved to be such a solvent, and solidified alloys of gold containing not more than 30 per cent. of lead and of zinc, may be made practically uniform in composition by adding 15 per cent. of silver to the mass when fluid. The result is singular, as it shows that there are cases in which the uniformity of a gold alloy may be improved by lowering its standard fineness; and another proof of scientific interest is afforded of the fact that alloys behave like saline solutions.

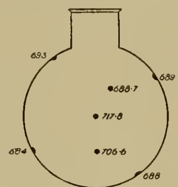


FIG. 1.—Gold 700 parts, lead 300 parts; weight about two kilograms.

The result shows a decided tendency of the gold *to liquate to the centre of the mass.*

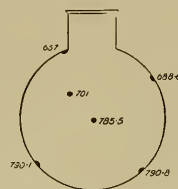


FIG. 2.—Gold 75 parts, lead 15 parts, zinc 10 parts; weight about two kilograms.

There is evidence of rearrangement by liquation in this case which sends gold to the centre, but the result is complicated, as gravity appears also to send gold to the lower portion of the spherical mass.

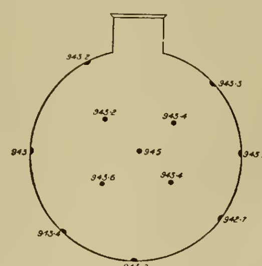


FIG. 5.—Gold 95 parts, zinc 5 parts; weight 4·430 kilograms.

A slight but decided tendency of liquation of gold towards the centre.

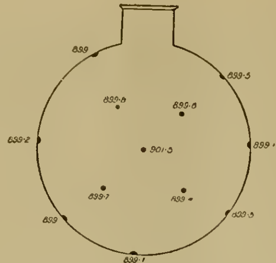


FIG. 7.—Gold 90 parts, zinc 10 parts; weight 4·200 kilograms.

This shows that there is still a tendency in this gold alloy with 10 per cent. of zinc to become enriched towards the centre.

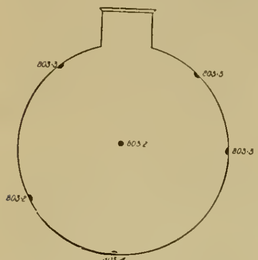


FIG. 9.—Gold 77·5 parts, silver 7·5 parts, zinc 15 parts; weight 3·930 kilograms.

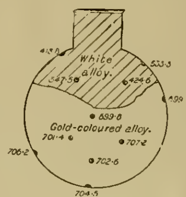


FIG. 11.—Gold 63 parts, silver 7 parts, lead 20 parts, zinc 10 parts.

Very marked separation takes place here, the difference at various points of the sphere being very remarkable, and forcibly illustrating the difficulties to which reference is made at the commencement of this paper.

As, however, it appears, that when a certain amount of silver is present, the irregularity in composition disappears, this mixture of—

Zinc...	10
Lead	20
Silver	7
Gold	63

was alloyed with more silver, so that it contained 15 per cent. of silver (nearly half the united amounts of zinc and lead present in the alloy).

This, cast into the 3-in. spherical mould, showed the following results at the points indicated. In *appearance*, the metal, when sawn in two, was homogeneous.

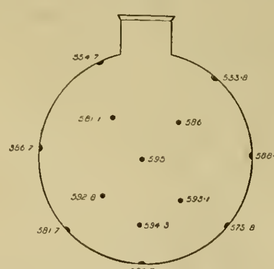


FIG. 12.—Alloyed so as to contain 15 per cent. silver; weight 3·450 kilograms.

There is here still evidence of liquation of gold towards the centre, but comparison of Fig. 12 with that which immediately precedes it will show how greatly the arrangement of the alloy has been modified by the presence of the additional 8 per cent. of silver. The proportion of silver in this alloy was proved by assay to be 15·5 per cent.

As there was still evidence of liquation, the metal was cast with still more silver, making 20 per cent. of silver in all. The alloy, when cast into a mould, proved to be almost uniform in composition, the difference between the centre and the extreme portions being very slight.

Liquation had practically ceased, a fact which proves incontestably that silver is the solvent for the base metals, zinc, and lead, when they are alloyed with gold.

Conclusions.—(1) Alloys of gold with base metals, notably with lead and zinc, now often met with in industry, have the gold concentrated towards the centre and lower portions, which renders it impossible to ascertain their true value with even an approximation to accuracy.

(2) When silver is also present these irregularities are greatly modified.

The method of obtaining "cooling-curves" of the alloys shows that the freezing points are very different when silver is present in the alloy and when it is absent from it.

(3) This fact naturally leads to the belief that if the base metal present does not exceed 30 per cent., silver will dissolve it and form a uniform alloy with gold.

(4) This conclusion is sustained by the experiments illustrated by Figs. 9, 11 and 12, which, in fact gradually lead up to it, and enable a question of much interest to be solved.

EDWARD MATTHEY.

THE ATOMIC WEIGHT OF OXYGEN.[1]

THIS monograph embraces a complete collection of the results obtained by Dr. Morley while working on this subject, and gives a detailed account of the various apparatus used. The experiments described extended over a very lengthened period. They consisted of the determination of the ratio between oxygen and hydrogen by two distinct methods, viz. by actually weighing the gases and by synthetising water. In all his experiments Dr. Morley dealt with far larger volumes of purer gases than previous experimenters had used, and in weighing them he reduced with surprising completeness every possible source of error. In his work on the synthesis of water, Dr. Morley succeeded in weighing the hydrogen and oxygen burned, and also the water produced thereby, achieving an exactness not attained by any previous experimenter, as none before had weighed all three factors. All experiments dealing quantitatively with gases are naturally extremely difficult, but Dr. Morley has, by paying attention to every detail, brought each process to a great pitch of accuracy.

The major corrections that were introduced into the determinations were as follows.

(1) The expansion of the glass of the globes.
(2) The errors of the mercurial thermometers.
(3) The deviation of the mercurial from the hydrogen thermometer.
(4) The difference between the coefficients of expansion of oxygen and hydrogen.
(5) The elevation of the cistern of the barometer above the centre of the globe when reading pressure.
(6) The correction of the scale of the barometer.
(7) The force of gravity at the laboratory.

In weighing the gases Dr. Morley employed large glass globes varying in capacity from nine to twenty-one litres. All data connected with the capacity of these were accurately determined. As the globes were so large it was found impossible to weigh them full of water to measure their capacity, and a different method had to be adopted. The globes were first weighed in air, then sunk in water, the weights being determined to keep the globes immersed; lastly the globes were filled with water, and again weighed in water. From these were obtained the external volume, the solid contents, and the capacity within ·02 per cent. In introducing a correction for the compression of the globes when exhausted, Dr. Morley devised an exceedingly ingenious plan. The compression itself was determined by placing the globe in a copper cylinder, which was then closed

1 "On the Densities of Oxygen and Hydrogen, and on the Ratios of their Atomic Weights," by Dr. E. W. Morley. *Smithsonian Contributions to Knowledge*, No. 980. (Washington, 1895.)

and filled with water. A small tube led from the cylinder to a burette containing water. When the globe was exhausted the compression was measured by the amount of water run into the cylinder from the burette. Each globe was provided with a counterpoise of equal external volume when exhausted. A pair of small flasks were then made, the difference between whose volumes was equal to the amount of compression just measured, and whose weights in vacuo were equal.

For example, the actual compression of one globe was 1·27 cc. The two small flasks were made 2·08 and ·81 cc. in volume and of the same weight when weighed in vacuo; therefore when weighed in air they differed in weight by the weight of 1·27 cc. of the air at the time, taking into account the true value of the weights employed. When the globe was exhausted it was weighed against the counterpoise which had the same volume. When it was full of gas it was tared with the ·81 cc. flask against the counterpoise and the 2·08 cc. flask; the *true* weights of the globes therefore suffered equal additions, with the result that the *apparent* difference in weight would be the *true* difference as expressed by brass weights in air.

The measurement of pressure and temperature, Dr. Morley took especial pains to make as accurate as possible. In the many series of experiments which are comprised in this great research, different methods were adopted of measuring these values. When thermometers were used great care was taken in determining their errors, and in the calculation of the pressures the value of the force of gravity as actually determined at Dr. Morley's laboratory was used.

Dr. Morley's determinations are divided into four series.

The first series consists of the determination of the weight of one litre of oxygen.

The second series consists of a similar determination for hydrogen.

The third series contains some experiments to determine the volumetric composition of water.

The fourth is a series of syntheses of weighed quantities of water from weighed quantities of oxygen and hydrogen.

The first series of determinations are those of the weight of a litre of oxygen under standard conditions. Three different methods were adopted.

In the first the temperature and pressure were directly determined by use of thermometers and a manobarometer.

In the second method the temperature and pressure were not directly determined, but made equal to those of a standard volume of hydrogen.

In the third method the pressure was alone read, the temperature being that of melting ice.

The oxygen for this series of experiments was obtained from potassium chlorate. The salt was placed in a hard glass tube in a combustion furnace; this tube was joined to the rest of the apparatus by means of a ground joint cemented with wax. Dr. Morley made a point of using no rubber connections in any of his experiments, rightly observing that even though the leakage may be exceedingly small, still the extra trouble entailed by fusing all joints together is worthily bestowed. Dr. Morley says there is no reason to doubt the purity of this oxygen; nitrogen he sought for particularly, and found quantities varying from 1/12,000th to 1/5,000,000th, which are quite negligible, considering the closeness of the atomic weights of the two gases.

Dr. Morley discusses the question of mercury vapour, and reasons from his experiments on hydrogen that the error is not greater than the ten- or twenty-thousandth part of the density of oxygen.

The pressure in these experiments was measured by means of a manobarometer, which consisted of a barometer and two gauges mounted in the same trough of mercury. One of these gauges was used for oxygen and the other for hydrogen, the experiments on which were carried out at the same time. The barometer and gauges were placed in a cistern of water with plate-glass sides. In front of each tube, and in contact with it, was a glass millimetre scale. The three scales were adjusted so that their zero points were all on the same level. The cathetometer used for reading had two telescopes, each with a micrometer eyepiece. The accuracy of reading was found to be within 1/100th mm.

In weighing the globes Dr. Morley met at first with great difficulty, owing to currents of air disturbing the globes. Their effect was, however, almost destroyed by hanging the globes in a sheet-iron box, which was in its turn placed in a non-conducting chamber under the balance. The balance was one of Becker's make, and had never been used for any other purpose.

The mean of nine determinations by this method of the weight of a litre of oxygen is

$$1 \cdot 42879 \text{ gr.} \pm \cdot 000034.$$

In the second method of weighing oxygen, the pressure and temperature were made equal to those of a standard volume of hydrogen. The preliminary part of this process was to fill a globe with pure hydrogen, and measure the pressure exerted by the gas on one leg of a differential manometer. This instrument was of the ordinary **U** shape, adjustment of the mercury being made to two needle-points, one in each limb. The globe containing the oxygen was then attached to the opposite limb, and the pressure adjusted till exactly equal to that of the hydrogen. A new balance was employed in these determinations, purchased especially for this work, and lent Dr. Morley by the Smithsonian Institution. Weighing was performed by reversal, the relative position of globe and counterpoise being changed by mechanical means.

Dr. Morley publishes fifteen determinations of the weight of a litre of oxygen by this method. The mean is

$$1 \cdot 42887 \text{ gr.} \pm \cdot 000048.$$

The method employed in the third series of determinations was to determine the pressure of the oxygen by means of the syphon barometer, the temperature being 0° C. The globe was immersed in ice, the layer of ice all round the globe being 30 centimetres thick. The globe was then exhausted and oxygen admitted, and its pressure measured. After weighing the globe was again exhausted and again weighed, the difference being taken as the weight of the oxygen. The reason for this procedure was the fact of the globe being exposed to the action of water for such a long time.

As a mean of twenty-four experiments, Dr. Morley gives

$$D = 1 \cdot 42917 \text{ gr.} \pm \cdot 000048.$$

We have, therefore, the following three mean results by the three different methods.

By use of thermometer and manobarometer	1·42879 ±	·000034
By compensation	1·42887	·000048
By use of ice and barometer ...	1·42917	·000048

In computing a final mean from these, Dr. Morley discusses the relative reliability of the results. He gives double weight to the third method, for, though involving more accidental errors, it involves no constant error common to the other methods.

Dr. Morley gives his final value for the weight of 1 litre of oxygen measured at 0° and 760 mm. at sea-level, and 45° lat., as 1·42900 gr. ± ·000034.

The second part of Dr. Morley's paper deals with his determinations of the weight of 1 litre of hydrogen under standard conditions.

Five series were made. In the first, pressure and temperature were measured; in the second, pressure only was measured, the temperature being equal to that of melting ice; in the third, the hydrogen was weighed in combination with palladium before introduction into the globe. The fourth and fifth were repetitions of the third.

The first series of determinations were carried out in exactly the same manner as the first series with oxygen, indeed at the same time. The hydrogen was prepared by the electrolysis of dilute sulphuric acid.

Dr. Morley adopted elaborate methods to measure the impurity in the hydrogen. He introduced a correction for the nitrogen found until, owing to an improvement of the apparatus, this percentage of nitrogen became so small as to be entirely negligible.

The mean of fifteen results obtained by this method is

$$D = \cdot 089938 \text{ gr.} \pm \cdot 000007.$$

The second method was to read pressure only, the temperature being 0° C. The details are exactly the same as in the similar case with oxygen.

The mean of nineteen experiments is

$$D = \cdot 089970 \pm \cdot 000011.$$

The third method, that of weighing the hydrogen contained in palladium, is one that is far more likely to prove accurate than methods depending on the weighing directly of a known volume

of hydrogen. For in the best case the weight of the globe was 600 times the weight of the hydrogen contained in it. The great advantage, however, to be gained from this method is the absence of any error introduced by mercury vapour, for it would have no effect on the weight of the hydrogen, and the volume and pressure of the residual mercury vapour are far too small to influence results. Dr. Morley has given especial attention to this method, and has brought it to a very great pitch of accuracy.

The palladium was placed in a tube which could be connected with the apparatus by a ground-glass joint. When the palladium was charged with hydrogen the tube was weighed. Connection being now made, a fusible metal plug, which took the place of a stop-cock, was melted, and the hydrogen passed into the globes. The tube was afterwards weighed, the difference giving the weight of hydrogen, usually about 3·7 grammes. This was found sufficient to fill three globes.

The mean of eight results in one series is

$$D = \cdot 089886 \pm \cdot 0000049.$$

The mean of four results in a second series is

$$D = \cdot 089880 \pm \cdot 0000088.$$

The mean of eleven results with a new apparatus,

$$D = \cdot 089866 \pm \cdot 0000034.$$

Dr. Morley gives as his final result for the weight of one litre of hydrogen under standard conditions,

$$\cdot 089873 \pm \cdot 0000027 \text{ gr.}$$

The third part of the paper deals with the determination of the volumetric composition of water. The electrolytic gas was produced in a voltameter, whose loss of weight gave the weight of gas used. This gas was admitted into globes of known volume, plunged in ice, where its pressure was measured. From these it was transferred to an eudiometer and exploded. The weight of gas usually dealt with was about 23 grammes. The explosion of the gases was carried on in a eudiometer, where all but 1/100th or 1/1000th part of the gas could be exploded out of contact with mercury. In all Dr. Morley's results he found excess of hydrogen, due to secondary reactions in the voltameter.

The mean value determined by ten experiments of the ratio of the excess of hydrogen to the whole combined volume of hydrogen and oxygen is ·000293. This value $\times$ 3 = ·00088 gives a correction to be applied to the ratio of hydrogen and oxygen, in order to obtain the ratio of volumes of hydrogen and oxygen that would combine without residue.

The mean of the ten experiments gives the value of the density of the electrolytic gas as

$$= \cdot 535510 \pm \cdot 000010.$$

In calculating the ratio of combining volumes, Dr. Morley takes into account the deviation of the mixed gases from the density computed by Boyle's law, and also the values of the constant a in Van der Vaals's equation. He obtains the ratio of mixture to be 2·000357, which, corrected for known excess of hydrogen, gives ratio of combining volumes to be

$$2 \cdot 00269.$$

The fourth and last portion of the experimental portion of the paper deals with the syntheses of water from weighed quantities of oxygen and hydrogen. The hydrogen was weighed, absorbed by palladium, the oxygen weighed in a globe, and the two were combined together in a combustion apparatus, whose gain in weight gave the weight of water produced. The quantity of hydrogen used was about 42 or 43 litres; the measured residue of uncombined gas varied from 1/100th to 1/10,000th of quantity concerned. The combustion apparatus was plunged in water during the union of the two gases, in order to keep it cool. This process took about one and a half hours, and was carried on as far as possible. The remaining gas in the various parts of the apparatus was pumped out and analysed, the combustion apparatus being kept in a freezing mixture, to keep as low as possible the vapour pressure of the water. The rest of the process needs no description.

As regards two possible sources of error which have been suggested, Dr. Morley proved conclusively that his hydrogen from palladium contained no water, and that his phosphorus pentoxide absorbed no oxygen.

As the mean of twelve experiments, Dr. Morley gives the atomic weight of oxygen to be very nearly

$$15 \cdot 879.$$

In collating all the results of his experiments, Dr. Morley gives the following values:

Weight of one litre of oxygen	1·42900
Weight of one litre of hydrogen	0·089873
Atomic weight of oxygen (chemical method) ...	15·879
Molecular weight of water (chemical method)...	15·879
Atomic weight of oxygen (physical method) ...	15·879

The probable accuracy of Dr. Morley's work appears to be exceedingly high, for he has in several cases spent especial trouble and time in eliminating hitherto constant sources of error. The extremely ingenious forms of apparatus he used for his many determinations are especially worthy of remark; and these, together with the extraordinary care bestowed in their use, combine to make the whole rank among the finest investigations of modern science.

E. C. C. BALY.

SCIENCE IN THE MAGAZINES.

THE relation of complexion to disease is discussed by Dr. John Beddoe, F.R.S., in the course of a paper in *Science Progress*. Baxter's great work on the medical statistics of the Civil War contains evidence as to the greater liability of blonds to certain classes of disease (in America at least). It follows from this that the blonds in America have less chance than the brunets of contributing their due proportion to the next generation, and therefore the blonds ought to diminish relatively, and the brunets to increase.

As bearing upon this, it appears that of accepted soldiers from among the white natives of the United States, 66 per cent. were light and 34 dark complexioned, but the proportion for English, Irish, and Germans is 70 to 30. Thus, Dr. Beddoe points out, the men of American birth yielded a larger proportion of brunets than those of any of the nations that had contributed to their ancestry, which is nearly equivalent to saying that the Americans are more generally dark complexioned than their ancestors were. Statistics as to the colours of school children of Germany, Austria, Switzerland, and Belgium, and of adults in Italy and the British Isles, seem to furnish sufficient evidence that in a great part of Europe the citizens are darker than the peasantry. Why the blond type should be more susceptible than the brown to the malign influences of urban life is a difficult question to decide.

Other articles in *Science Progress* are:—"Prehistoric Man in the Eastern Mediterranean," by Mr. J. L. Myres; "The Graptolites," by Mr. J. E. Marr; "Insular Floras," by Mr. W. B. Hemsley; and "Recent Discoveries in Avian Palæontology," by Mr. C. W. Andrews.

There are several articles in the *Contemporary* to which attention may be directed here. Mr. Phil Robinson describes "The First Nest of a Rookery," in a pleasantly-written paper, but the interpretations of his observations are made too much from the humanistic point of view. Dr. Lennox Browne attacks "The Antitoxin Treatment of Diphtheria," his criticism being based mainly upon the Report of the Metropolitan Asylums Board, summarised in these columns in April last (vol. liii. p. 524). He claims that the mortality of cases treated by antitoxin at the London hospitals in 1895 is but a trifle lower than that of the previous year, and is in excess of what has been obtained in individual hospitals of the series whence the Report is issued; and, also, that this improvement has not been due to the serum treatment, but rather to increased vigilance and nursing care. Some "Girls' Technical Schools on the Continent" are described by Marion Mulhall. The article shows how the technical instruction of girls now takes a front rank in the cares and duties of many municipal authorities in Holland, Belgium, Germany and Austria.

Sir W. M. Conway describes in *Scribner* his walk of "A Thousand Miles through the Alps," and concludes his narrative with a comparison between Switzerland and the Tyrol from a traveller's point of view, much to the advantage of the latter. He says, and there are many ready to corroborate his statements, "Whereas travel in Switzerland is exploited by hotel-keepers and organised in their interests, the Tyrol is, through the agency of the powerful German and Austrian Alpine Club, organised by travellers themselves in their own interests. In Switzerland, traps are laid for the tourist's francs; in the Tyrol, every effort is made to spare his pocket." The Tyrol is far ahead of Switzerland in climber's food, in mountain huts,

and in all other facilities for mountaineering away from crowds of tourists. "In fine," concludes Sir Martin Conway, "no part of the Alps now forms a better training-ground for the youthful would-be mountaineer, none a less vulgarised holiday resort for the man of moderate physical capabilities, simple tastes, or restricted means, than the region comprised in the Austrian and Bavarian Tyrol."

In *Scribner* there is also an article on scientific taxidermy, under the title "A Lost Art," by Mr. J. Carter Beard. The reform in taxidermic methods is said to have begun fifteen years ago. As instances of successful work are cited Mr. W. T. Hornaday's "Fight in the Tree-Tops," illustrating a characteristic episode in the lives of orang-utans, whose habits he had studied in their native forests, and whose skins and skeletons he had himself collected; Mr. Hornaday's group of flamingoes, and groups of bison, in the U.S. National Museum, and New York Museum of Natural History; a group of Rocky Mountain goats, by Prof. L. L. Dyche; a young camel, by Mr. Rowley, in the latter Museum, and the rehabilitation of "Chico," a large ape, done for the same museum by the same taxidermist. Nothing is said of any of the specimens in our own Natural History Museum.

The *Geographical Journal* contains the address delivered by Sir Clements Markham at the recent anniversary meeting of the Royal Geographical Society. There are also contributions on "The Pamirs and the Source of the Oxus," by the Right Hon. George N. Curzon; "Admiralty Surveys during the Year 1895"; "The Indian Surveys 1894–95," by Mr. C. E. D. Black; and "Geography at the Universities." In the *Contemporary*, Mr. A. E. Pease has a short article on the political geography of "Africa North of the Equator." The *Century* contains "Glimpses of Venezuela and Guiana," by Mr. W. N. King; a short paper on Eskimo life, entitled "An Arctic Studio (77° 44′ N. lat.)," by F. W. Stokes; and "Impressions of South Africa," by Mr. James Bryce.

A passing mention must suffice for the remaining articles of scientific interest in the magazines and reviews received. Under the title "Stray Thoughts on South Africa," Olive Schreiner contributes to the *Fortnightly* some facts as to the crossing of races in South Africa and the results of the mixture of blood; Prof. Max Müller's paper on "Coincidences," read before the Royal Society of Literature in May last, appears in the same review. Dr. Louis Robinson discusses, in the *National*, some aspects of "The Science of Change of Air," and offers a few sensible and seasonable suggestions on the subject. Mr. F. E. Hewitt has in the *Westminster Review* a historical study entitled "How the First Priests, the long-haired Shamans, and their successors, the Tonsured Barber-Surgeons, measured Time." To *Longman's Magazine* Mr. Grant Allen contributes a popular paper on "Lobsters at Home." Mr. James Buckland describes in the *English Illustrated Magazine* the remarkable mode of nidification of the hornbills, and makes a conjecture why the male bird plasters up the nest and keeps the female a prisoner until the eggs are hatched. Finally, *Chambers's Journal* contains its usual complement of instructive articles, among the subjects being Mr. Carey Lea's work on modifications of silver, and artificial perfumes of flowers.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—An examination in natural science (chemistry and physics) will be held on Wednesday, October 7, for the purpose of filling up a Bristol scholarship (open *pro hac vice*) of the annual value of £100 and tenable (under the usual conditions) for five years; the successful candidate to commence residence immediately upon election.

DR. T. M. LEGG has been appointed Professor of Hygiene in Bedford College, London.

THE widow of the late Dr. Arthur Jackson, of Sheffield, has presented £5000 to the Sheffield School of Medicine to endow a chair of Anatomy, to be named after her late husband.

THE Council of University College, London, have instituted a new Professorship of Pathological Chemistry, and have appointed Dr. Vaughan Harley to the professorship.

THE Cornell University has issued, in the form of a slender *brochure*, its programme of courses of instruction in physics for the session 1896–97. The Department of Physics occupies a large building known as Franklin Hall, and the equipment is valued at 50,000 dols. Prof. E L. Nichols has the services of an efficient staff, consisting of three assistant professors and seven instructors. The curriculum includes elementary courses for senior and junior students, advanced work both for undergraduates and graduates, and courses given in the summer school from July 6 to August 16. Among other encouragements for research, one university fellowship and one graduate scholarship in physics are awarded each year. With a view to affording still further stimulus for research, the University, three years ago, founded the *Physical Review*, which is the only journal in America devoted exclusively to physics. Such enterprise furnishes an example which our older English universities would do well to emulate.

THE Duke of Bedford has placed at the disposal of the Technical Instruction Committee of the Bedfordshire County Council a farm of 275 acres, 149 of which are arable land and the rest grass. In addition to this his Grace has erected the necessary lecture-rooms, dormitories, and other buildings for the accommodation of twenty students. Twenty boys are granted free scholarships by the County Council, entitling them to two years' board, residence, and instruction in the science and practice of farming. On Tuesday, June 30, the members of the Bedfordshire County Council were able, at the invitation of the Duke, to pay a visit of inspection to the farm, and are able to report that every branch of farm and garden practice is efficiently taught by means of models and specimens in school and of actual work on the farm, in the dairy, poultry-yard, and garden. The institution is modelled on the lines of similar school farms on the continent, which were inspected and reported upon by the Organising Secretary of Technical Instruction some time ago.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 4.—"On the unknown Lines observed in the Spectra of certain Minerals." By J. Norman Lockyer, C.B., F.R.S.

In the first note of the series "On the New Gases obtained from Uraninite," by the distillation method, the author remarked[1] "I have already obtained evidence that the method I have indicated may ultimately provide us with other new gases, the lines of which are also associated with those of the chromosphere."

In a subsequent paper "On the Gases obtained from the Mineral Eliasite," he gave a list of several unknown lines, and suggested that they might indicate the existence of a new gas or gases in that mineral, and added[2] "Although the evidence in favour of a new gas is already very strong, no final verdict can be given until the spectra of all the known gases, including argon, have been photographed at atmospheric pressure, and the lines tabulated. This part of the inquiry is well in hand."

The inquiry above referred to has now been completed and in the following manner:—

Photographs were taken of the spectra at atmospheric pressure of nitrogen, oxygen chlorine, carbonic anhydride, coal gas, sulphuric anhydride, phosphoretted hydrogen, and argon, these being the gases which, from the experience thus far acquired are likely to be associated with those given off by minerals. In addition to these the lines of mercury, potassium, and platinum, were also photographed. The lines of platinum are always present in the spectra for the reason that the spark is passed between platinum poles, while the lines of mercury or potassium frequently appear according as the gases are collected over mercury or potash.

For the wave-lengths thus obtained no greater accuracy than one indicated by four figures is claimed. It was the author's intention, in the first instance, to give five figures from the more elaborate tables of some of the elements given by other observers, but this had to be abandoned in consequence of the considerable variations found in the tables between the results as given by different observers.

A list is given of sixty lines which have been observed and photographed in the spectrum of the gases from eliasite which do not appear in the spectra of the old gases.

[1] *Roy. Soc. Proc.*, vol. lviii. p. 70.
[2] *Ibid.*, vol. lix. p. 3.

UNKNOWN LINES OCCURRING IN VARIOUS MINERALS

Wave-length (s) determined by four-prism Steinheil.	Bröggerite.	Eliasite.	Samarskite.	Gummite.	Uranocircite.	Monazite.	Yttro-Gummite.	Orangite (thorite).	Calco-uranite.	Gadolinite.	Manganese nodule.	Thorite.	Euxenite.	Sun. Chromosphere (Young).	Sun. Eclipse 1893.	Stars.
3898·2	...	×														
3899·0	...	×	×													
3905·8	...	×	...	...	...	...	...	...	...	...	...	...	...	3905·6	...	3906·2 α Cygni
3907·0	...	×	×	...	...	...	...	...	...	...	...	...	...	...	3907·7	
3915·0	...	...	...	...	...	×										
3929·0	...	×	...	...	...	...	...	...	...	...	...	...	...	3928·1	3929·4	3929·4 δ Orionis
3961·4	...	×	...	...	...	...	...	...	...	...	...	...	...	...	3961·7	3961·6 α Cygni
3972·0	...	...	...	...	...	×	...	...	...	...	...	...	...	3971·0 (2)		
3979·9	...	×														
4002·0	...	...	×	...	...	...	...	...	...	...	...	...	...	...	...	4002·9 α Cygni
4015·0	...	×	...	...	...	...	...	...	...	...	...	...	...	...	...	4015·7 α Cygni
4035·2	...	×	...	...	...	...	...	...	...	...	...	...	...	...	{ 4034·64 4035·88	
4056·0	...	×	×													
4058·6	...	×	...	...	...	...	...	...	...	...	...	...	...	...	4859·1	
4071·0	...	...	...	...	...	×	...	...	...	...	...	...	...	...	4071·90	4070 Bellatrix, δ Orionis, α Virginis
4072·8	...	×	...	...	...	...	...	...	...	...	...	...	...	...	...	4072·2 α Cygni, Bellatrix
4082·0	...	...	...	...	...	×										
4114·0	...	×	×	...	...	...	...	...	...	...	...	...	...	...	4115·0	4115 δ Orionis
4128·3	...	×	...	...	...	...	...	...	...	...	...	...	...	...	4127·9	4128·6 α Cygni, Rigel
4131·4	...	×	...	...	...	...	...	...	...	...	...	...	...	...	4131·4	4131·4 α Cygni, Rigel
4224·0	...	×	...	...	...	...	...	...	...	...	...	...	...	...	4224·3	
4255·7	...	×	...	...	...	...	...	...	...	...	...	...	...	...	4256·0	
4264·0	...	×	...	...	...	...	...	...	...	...	...	...	...	...	4264·5	
4277·0	...	×	×													
4283·0	...	×	...	...	...	...	...	...	...	...	...	...	...	...	4282·8	
4292·0	...	×	...	...	...	...	...	...	...	...	...	...	...	...	4291·5	
4309·3	...	×	×	...	...	...	...	...	...	...	...	...	...	...	...	4309·4 α Cygni
4312·2	...	×	...	...	...	...	...	...	...	...	...	...	...	...	4313·2	4312·8 α Cygni
4338·5	...	×	×	...	...	...	...	...	...	...	...	...	...	4339·0 (10)	...	4338·0 α Cygni
4427·3	...	×	...	...	...	...	...	...	...	...	...	...	...	4426·6 (2)	4427·3	
4442·5	...	×	...	...	...	...	...	...	...	...	...	...	...	4443·5 (10)		
4483·0	...	...	...	...	...	×	...	...	...	...	...	...	...	...	4482·2	
4953·0	...	...	...	...	×											
5014·0	...	...	...	×												
5165·0	...	...	...	...	...	...	...	...	...	...	×					
5175·0	...	...	...	...	...	...	...	...	...	...	×					
5188·0	...	...	...	...	...	...	...	...	...	...	×	...	...	5188·1 (1)		
5202·0	...	...	...	...	...	...	...	...	×	...	...	...	...	5202·48 (5)		
5215·0	...	×	...	...	...	...	...	...	...	...	...	...	...	5215·35 (2)		
5220·0	...	...	...	...	...	...	...	×								
5380·0	×	...	...	...	...	...	...	...	×							
5404·1 (s)	...	×	...	...	...	...	...	...	...	...	...	...	...	5404·1 (5)		
5429·9 (s)	...	×	...	...	...	...	...	...	...	...	...	...	...	5429·9 (8)		
5485·0	×	×	...	×	...	×	...	...	...		...	...	×			
5505·0	...	×	...	...	...	×										
5515·0	×															
5575·0	...	...	...	...	...	×	...	...	×		...	×				
5598·0	...	×														
5650·0	...	...	...	...	...	...	...	×								
5660·0	...	...	...	...	...	...	...	...	×	...	...	×				

Wave-length (s) determined by four-prism Steinheil.	Bröggerite.	Eliasite.	Samarskite.	Gummite.	Uranocircite.	Monazite.	Yttro-Gummite.	Orangite (thorite).	Calco-uranite.	Gadolinite.	Manganese nodule.	Thorite.	Euxenite.	Sun. Chromosphere (Young).	Sun. Eclipse 1893	Stars.
5676·0	...	...	...	...	×	...	...	...	...	...	×					
5715·0	...	...	...	...	...	...	×									
5777·0	...	×														
5780·9 (s)	...	×														
5785·0	...	×														
5846·8 (s)	...	×														
5915·0	...	...	...	...	×	...	...	...	...	...	...	...	...	5914·38 (2)		
5984·0 (s)	...	×														
5991·6 (s)	...	×	...	...	...	...	...	...	...	...	...	...	...	5991·6 (10)		
6000·0	...	...	...	...	...	...	...	...	...	×						
6025·0 (s)	...	×	×													
6030·0	×	×	×													
6035·0	...	×														
6043·0	...	×														
6047·1 (s)	×	×														
6060·0	...	...	...	...	...	...	...	...	...	×						
6064·0	...	...	...	...	×	×										
6065·7 (s)	...	×	×	...	...	...	...	...	...	...	...	...	...	6065·71 (5)		
6066·1 (s)	...	...	...	...	...	×										
6070·0 (s)	×	×	...	...	...	×										
6071·6 (s)	×	...	...	...	×											
6080·0	...	...	...	...	...	...	...	×								
6090·0	...	×														
6098·9 (s)	...	×														
6105·0	...	×														
6110·0	×															
6112·0	...	×	...	...	...	...	...	...	...	...	...	...	...	6111·29 (2)		
6114·5 (s)	...	×														
6115·9 (s)	...	×	...	×	...	...	...	...	...	...	...	×				
6122·43 (s)	...	×	×	×	×	×	×	...	...	...	...	...	...	6122·43 (5)		
6140·0 (s)	...	×														
6141·9 (s)	...	...	...	×	...	...	...	...	...	...	...	...	...	6141·93 (25)		
6162·4 (s)	...	...	×	...	...	...	...	...	...	...	...	...	...	6162·38 (8)		
6215·0	...	×	...	...	...	...	...	...	...	...	...	...	...	6215·3 (3)		
6218·3 (s)	...	×														
{ 6219·0	...	×	...	...	...	...	...	...	...	...	...	...	...	6219·49 (3)		
{ 6220·0	...	×														
6278·0	...	×														
6295·0	...	×														
6313·5 (s)	×	×														
6347·4 (s)	×	...	×	×	×	...	×	...	...	...	...	...	...	6347·3 (10)		
6350·1	×	...	...	×												
6371·1 (s)	×	...	...	×	...	...	...	...	...	...	...	...	...	6371·6 (5)		
6415·0	...	×														
6452·0	...	...	...	×												
6465·0	...	×														
6475·0	×															
6485·0	...	...	...	...	...	...	...									
6489·0	...	...	...	×												
6500·0	...	...	...	...	...	...	...	...	...	...	...	×				
6640·0	...	...	...	×												
6740·0	...	...	...	×												

The author also gives a complete list of the unknown lines so far as the observations have at present gone, indicating their mineral origins, and whether or not lines nearly coincident in position have been observed in any celestial body.

This table includes about a hundred lines, a large number of which have celestial coincidences.

June 18.—"Complete Freezing-point Curves of Alloys containing Silver or Copper and another Metal." By C. T. Heycock and F. H. Neville.

From a study of dilute solutions of metals in copper, the authors arrive at 50 calories as a probable value for the latent heat of fusion of copper. The freezing-point curve of alloys containing silver and copper does not indicate the existence of any chemical compounds of these metals; but the eutectic alloy has exactly the composition Ag_3Cu_2. Lead copper alloys have a freezing-point curve characteristic of substances which are partially soluble in each other. The tin copper curve is remarkable for a singularity near $SnCu_6$, and another at exactly $SnCu_4$. The compound $SnCu_3$ is not clearly indicated in the curve.

For alloys whose composition is between $SnCu_6$ and $SnCu_4$, the freezing-point curve is perfectly straight, a feature that may be due to the separation of isomorphous mixtures of these bodies. Nickel and iron raise the freezing-point of copper, whilst gold and silver depress it.

Geological Society, June 24.—Dr. Henry Hicks, F.R.S., President, in the chair.—The President referred to the death of Sir Joseph Prestwich, and a resolution was passed assuring Lady Prestwich of the Society's heartfelt sympathy with her in the sad and irreparable loss that she has sustained.—Sir William Dawson, F.R.S., exhibited specimens and lantern-slides illustrating the general form, arrangement of laminæ, and distribution of the canals and tubuli in characteristic specimens of *Eozoon canadense*. He pointed out that an examination of these specimens and photographs might prevent mistakes likely to arise from the study of imperfect specimens, or from supposing that laminated rocks resembled *Eozoon*, and also that they exhibited additional peculiarities observed since the original publication of the description of *Eozoon* in the *Quarterly Journal* of the Society in 1865. He did not wish to enter upon any argument as to the nature of *Eozoon*, but merely to show the appearance of the principal structures on which the conclusion that it was of animal origin had been based. He also pointed out that these structures might be misunderstood when studied in imperfectly-preserved specimens, and that the wonder was not that so many specimens were imperfect, but that any structure had been preserved. He also shortly noticed the growing probabilities in favour of the existence of a rich marine fauna in pre-Cambrian times, and some of the discoveries in this direction already made or in progress.—Notes on the glacial geology of Arctic Europe and its islands. Part II. Arctic Norway, Russian Lapland, Novaya Zemlya, and Spitzbergen, by Col. H. W. Feilden; with an appendix by Prof. T. G. Bonney, F.R.S. The author gave an account of observations made in Arctic Norway, which tended to prove that the shell-bearing terraces were true marine deposits indicating uplift since their formation, and that they were not formed by ice-dams. He then described terraces recently formed in Kolguev Island, which illustrated the combined influence of pack-ice, sea-waves, and snow on the formation of terraces in a rising area. The glacial geology of the Kola Peninsula was next considered, and the distribution of the boulders noticed. There was no doubt that these boulders had been derived from local rocks, and that no ice-sheet from the North ever passed through Barents Sea or impinged on the northern coast of Europe. The author saw no evidence of the former extension of an ice-sheet over the now frost-riven rocks of Novaya Zemlya. He found wide-spread deposits of boulder-clay with marine shells in this region, which he attributed to the action of floating ice. In the Kostin Schar many of the islands were connected by ridges covered with rounded stones pushed up by floe-ice, with solid rock beneath glaciated by the floe-ice. Several minor phenomena connected with the glacial geology of Novaya Zemlya were also described. The raised beaches of Franz Josef Land were noticed, and immense deposits occurring in Spitzbergen, which were originally formed under water in front of glaciers, alluded to. These, as well as other submarine deposits of glacio-marine origin seen elsewhere by the author, showed no signs of stratification. Prof. Bonney described specimens brought by Col. Feilden from Norway, the Kola Peninsula, and Novaya Zemlya. From an examination of the rocks obtained *in situ* in the latter region, Prof. Bonney confirmed Col. Feilden's suggestion that the Kolguev erratics may have come from Novaya Zemlya.—Extrusive and intrusive igneous rocks as products of magmatic differentiation, by Prof. J. P. Iddings. The author, after pointing out the propositions concerning differentiation of magmas, upon which he is in agreement with Prof. Brögger, discussed the points of difference, and described the relation of the igneous rocks at Electric Peak to all of those which took part in the great series of eruptions which occupied almost the whole Tertiary period, and spread themselves over a vast territory in Montana, Wyoming, and Idaho. The author enunciated the principle that in a region of eruptive activity the succession of eruptions in general commences with magmas representing a mean composition and ends with those of extreme composition.

Edinburgh.

Royal Society, July 6.—The Hon. Lord M'Laren in the chair.—An obituary notice of the late Prof. James D. Dana was read by Prof. Geikie.—Dr. R. H. Traquair, F.R.S., read a paper on fossil-fishes from the Lower Devonian (*Hunsrückschiefer*) of Gmünden, Germany. Two species were described of which the first, *Drepanaspis Gmündenensis*, though named and briefly described by Schlüter in 1887, has hitherto been very imperfectly known. It has a hard and bony carapace composed of many tuberculated bony plates, a tail covered with rhombic sculptured scales, a heterocercal caudal fin bordered above and below with strong fulcra, but so far as can be seen there is no dorsal. There are no pectoral appendages. The position of mouth and eyes is still undetermined. The fish belongs undoubtedly to the *Ostracodermi*, and will form the type of a new family, *Drepanaspidæ*, whose position seems to be not far from that of the *Pteraspidæ*. The other species, *Coccosteus angustus*, Traq., was described as new—the ventral carapace is rather narrow, and the median dorsal plate shows evidence of an elevated median crest.—In the absence of Prof. Tait, Prof. Crum Brown briefly indicated the nature of his paper, a further communication on the kinetic theory of gases.—Dr. A. Lockhart Gillespie made a preliminary communication on digestion in some carnivorous plants. He gave a short *résumé* of the different classes of carnivorous plants, noting that the chief characteristic of all of them was not the power of converting native proteids into albumoses and peptones, but the complexity of the apparatus devoted to that end. In many plants, perhaps in all plants, peptonising ferments were present, especially in the seedlings, by which native proteids were resolved into diffusible forms which could be utilised in their nutrition. Darwin and others had shown in the case of *Pinguicula* and *Drosera* that many nitrogenous substances caused the glands of these plants to secrete an actively digestive juice. The author had investigated the action of the individual lower proteids on them, and also some of the lower derivatives of proteid digestion. He found that *Pinguicula* grew faster if fed once a week with a small quantity of proto-albumose than if nothing were given it, while raw egg-albumin, deutero-albumose, and peptone rather retarded its growth, especially the last. In fact, peptone (pure peptone, free from albumoses) killed the part of the leaf to which it was applied, after a few hours, however small the quantity. This was probably due to over-feeding. Serum globulin was slowly absorbed. Fibrin, coloured with carmine after Grützner's method, was not digestible; but egg albumin, coagulated in a weak solution of carmine, was slowly digested, and the glands could be seen coloured by the ingested carmine. He gave notes of the different times taken to absorb these various substances. *Drosera rotundifolia* reacted in a similar manner to these bodies. Its behaviour towards urea, kreatinin, tyrosin, nucleic acid, glycogen, and asparagin, was also investigated. Of these, only urea and asparagin were absorbed. Crystals of kreatinin were dissolved, but in a few days the leaf dried and the kreatinin could be seen crystallised out again on its surface. Crystals of urea, if very small, were readily absorbed; but, if large, speedily killed the leaf. Large quantities of asparagin were absorbed without detriment to the leaf, but these experiments were still in an unfinished state. With regard to the aggregation of protoplasm, as described by Darwin, Gillespie found that a very good way of obtaining permanent records of the process was to place the whole plant in a solution of some proteid weakly coloured with methylene blue, the protoplasm taking on the stain while the plant

continued to live. Under these circumstances the small sessile glands of *Drosera* stained deeply, showing that they became active in the presence of proteid material. Plants similarly treated with gentian-violet stained red where the glands were active, violet where they were only reflexly stimulated. The paper was illustrated by a number of lantern-slides and microscopic preparations.—Dr. C. G. Knott gave a summary of two papers by Mr. J. C. Beattie. The first was on the relation between the Hall effect and thermo-electricity in bismuth and in various alloys. That there was a connection was established, but what the precise nature of that relation was could not be determined till more definite knowledge of the Hall effect in alloys and with different temperatures, was arrived at. The second paper was on the curves of magnetisation for films of iron, cobalt, and nickel. The films were deposited on platinised glass and oscillated in the magnetic field. The results agreed with those already obtained for these metals in a solid condition.

PARIS.

Academy of Sciences, July 6.—M. A. Cornu in the chair.—The Secretary announced that the Institute would be able to award the Jean Jacques Berger Prize in 1897; the prize will be at the disposal of the Academy of Sciences in 1899.—Remarks by M. Albert Goudry on presenting a work on Philosophical Palæontology.—General laws of uniform flow in channels of large section, by M. J. Boussinesq.—Researches on tungsten, by M. H. Moissan. The pure metal is readily obtained by the reduction of tungstic acid with carbon in the electric furnace. With a large excess of carbon the carbide CW_2 is formed, which, in the fused state, readily dissolves more carbon, graphite crystallising out on cooling. Pure tungsten can be readily filed and forged, it welds easily, has no action upon a magnetic needle, and has a melting point higher than chromium and molybdenum.—On the solubility of carbon in rhodium, iridium and palladium, by the same. These three metals dissolve carbon with ease at the temperature of the electric furnace, and give it on solidifying in the form of graphite. No combination to form a carbide appears to take place.—Physiological action of high frequency currents; practical means for their continuous production, by M. A. d'Arsonval. When animals are placed within a solenoid traversed by currents of high frequency, the respiratory changes go on more rapidly. This was shown very simply by measuring the loss of weight in a given time.—Therapeutic effects of high frequency currents, by M. A. d'Arsonval. Since these currents have been found to cause a large increase in the rate of production of carbon dioxide in the body, it was thought that the application of such currents might give relief in diseases such as diabetes, gout and rheumatism, in which the rate of combustion is reduced. In two cases of diabetes the treatment produced marked relief.—On five photographs of the region round η-Argus, by Mr. David Gill.—Verification of Van der Waals's law of corresponding states, by M. E. H. Amagat.—Mr. Christie was elected Corresponding Member in the Section of Astronomy, in the place of Mr. Hind.—On a new capillary theory, by M. Marcellin Langlois.—A sealed note, by M. D. Loiseau, was opened: On some properties of raffinose, serving to estimate this substance in sugars.—On ordinary differential equations of the first order, by M. A. Korkine.—On the local attractions observed in Eastern Europe, by M. Venukoff. An account of the deviation of the pendulum in the neighbourhood of mountains in Bulgaria and in the Crimea.—On the refraction and diffraction of the X-rays, by M. Gouy. For the substances examined, the index of refraction, if not exactly unity, differs from it by a quantity less than the errors of experiment (·000001). As regards diffraction, none could be established with certainty, and the wave-length must be smaller than ·005 μ, or 1/100 of the wave-length for green light.—Composition of pendular movements, by MM. Jean and Louis Lecarme.—Comparative experiments on the pitch of cylindrical tubes vibrating transversely, by M. C. Decharme.—Action of zinc on the photographic plate, by M. R. Colson. The action has been traced to the vapour of zinc; it is most energetic after the surface has been cleaned with emery paper, but falls off as the surface oxidises. The practical conclusion is drawn that metallic zinc should not be used in the construction of the camera or dark box.—Action of nitrogen peroxide upon antimony trichloride, by M. V. Thomas. There appears to be no true compound formed, but only a solution of the gas in the trichloride.—The effect of a high temperature upon some sulphides, by M. A. Mourlot. In the electric furnace the amorphous sulphides of lead, antimony, zinc and cadmium are converted into galena, stibine, wurtzite, and greenockite respectively. The antimony sulphide gave some metallic antimony, but no trace of a sub-sulphide.—On two isomers of anethol (propenylanisol), by M. C. Moureu.—Action of ethoxalyl chloride upon naphthalene in presence of aluminium chloride, by M. L. Rousset. Two naphthylglyoxylic acids are obtained, the oximes of which on distilling *in vacuo* give (α) and (β)-naphthonitriles.—On amorphous greenockite of Laurium, by M. Christomanos.—Experimental researches on the effects of intravenous injections of saline solutions. Determination of their value in therapeutics, by MM. Bosc and Vedel.—Cutaneous evaporation in the rabbit; action of pilocarpine, by M. Lecercle.—On some points in the histology of the muscles of the Cirrhipedes, by M. A. Gruvel.—On an accidental parasite in man, belonging to the order of the *Thysanoures*, by MM. Frêche and Beille.—Influence of the composition of the water of lakes upon the formation of sub-lacustrine ravines, by M. A. Delebecque.—On a new sounding machine; portable apparatus with steel wire, by M. E. Belloc.

BOOKS RECEIVED.

BOOKS.—Year-Book of the U.S. Department of Agriculture, 1895 (Washington).—An Index to the Genera and Species of the Foraminifera: C. D. Sherborn, Part 2 (Washington, Smithsonian Institution).—Thirteenth Annual Report of the Bureau of Ethnology, 1891-92 (Washington).—Aus den Alpen: R. von Lendenfeld, 2 Vols. (Wien, Tempsky).—Report of the Chief of the Weather Bureau, 1894 (Washington).—Elementary Practical Chemistry, &c.: Prof. F. Clowes and J. B. Coleman (Churchill).—An Inquiry into the Alleged Liability of Wood Charcoal to Spontaneous Combustion, 3rd edition (A. Gardner).—Flora der Ostfriesischen Inseln: Dr. F. Buchenau (Leipzig, Engelmann).—Grundriss einer Geschichte der Naturwissenschaften: Dr. F. Dannemann, i. Band (Leipzig, Engelmann).—The Collected Mathematical Papers of Arthur Cayley, Vol. x. (Cambridge University Press).—The Official Guide to the Norwich Castle Museum: T. Southwell (Jarrold).—Grundriss einer Exacten Schöpfungsgeschichte: H. Habenicht (Wien, Hartleben).—A Geographical History of Mammals: R. Lydekker (Cambridge University Press).—Solutions to the Examples in Loney's Plane Trigonometry, Parts 1 and 2 (Cambridge University Press).—Wild Life of Scotland: J. H. Crawford (Macqueen).

CONTENTS.

THURSDAY, JULY 23, 1896.

GEOLOGY FOR STUDENTS.

The Student's Lyell; a Manual of Elementary Geology. Edited by John W. Judd, C.B., LL.D., F.R.S., Professor of Geology, and Dean of the Royal College of Science. 8vo. Pp. xxiv + 635. (London: John Murray, 1896.)

THERE are plants so deep-rooted in their native soil that time seems practically powerless to eradicate them, and even when razed to the ground, they will yet spring up again, from their tenacious hold in the heart of the earth beneath.

Thus it is with the teachings of Lyell; they have taken so strong a hold upon the minds of English geologists, that although the great historian of our science has been dead since 1875, yet his writings still illumine the path, and serve to guide full many a student who was unborn when Lyell died.

For the great "Principles of Geology," the inception of which takes us back to a far earlier period than the first edition of the "Student's Elements of Geology," indeed to more than sixty years ago, are still the guiding "principles" along which the great lines of geological thought continue to flow at the present day.

It is true that from 1858 Lyell became a thorough convert to the Darwinian theory of evolution, and, in the later editions of his works, he fully accepted the inevitable conclusions which these views involved; yet so far from weakening his hold on geological thought, the very openness of his mind proved him to be a teacher worthy to be followed and trusted, one who was able to accept new impressions and to advance, even in later life, along new lines of scientific thought.

In the work before us, we have embodied not only the survival of all that is best and fittest of Lyell's teachings, both in his "Elements" and "Principles," but also there has been superadded to the original work—by a species of "grafting" upon the parent Lyellian "stock"—a vigorous shoot from a new root—that of Prof. Judd, representing the later school of geology, as carried on in the Royal College of Science, South Kensington, formerly the Royal School of Mines, where, year after year, so many students have been trained to become geologists and to go forth to convert the wilderness into paying gold-fields, or to make geological maps of our colonies all over the world.

But much as this has added to the usefulness and up-to-dateness of the "Student's Lyell," we are reminded that other great "medicine-men" in geology have not hesitated to lend their aid to keep alive the school of Lyellian principles; and we may record that Profs. P. M. Duncan and T. G. Bonney, Mr. Etheridge, Prof. Rupert Jones, and Dr. W. F. Hume, have all helped to make this volume what it is to-day, a most useful and handy student's text-book of geology.

In spite of the expansion of the text, and the introduction into it of more than one hundred new illustrations, it has nevertheless been found possible, by using smaller type for certain portions, to avoid increasing the bulk or the cost of the volume.

Part i. embraces the introductory matter, such as the history of the development of geological science, the crust of the globe, and the nature of rocks and their classification.

The physical characters of the earth's crust, its chemical composition, and the distribution of temperature within the crust, has been entirely rewritten so as to embrace the latest information obtained by the most modern investigations.

The general relations of the stratified rocks, dealing also with the composition and classification of aqueous deposits in general, occupy the next hundred pages.

The following chapters treat of the chronology of the aqueous rocks, commencing with the Tertiary—these are disposed of in five chapters; the Secondary rocks occupy four more chapters, the Newer Palæozoic take fifty-eight pages, and the Older Palæozoic era is condensed into forty-one pages.

In dealing with the great series of aqueous or sedimentary rocks, more than five hundred figures of characteristic fossils are introduced into the text, and everywhere the importance of palæontological evidence as a means of determining the age of the rocks under consideration is pointed out; also the value of fossils as showing the earliest appearance in time of the various groups of living organisms is fully demonstrated.

Chapter xxix. gives us a general review of the sedimentary rocks; and here the student is made to understand that, as in the history of the human race, so it is with the history of the earth. In each case the later chapters are very fully and well preserved, and easily read and understood; but in both, the earlier portions become more and more fragmentary—often whole chapters are missing, and those which remain are frequently torn and mutilated.

"If we bear in mind how small must be the proportion of the relics of plants and animals now existing, that have any chance of being buried and preserved in the accumulations now being formed in seas and lakes; if we consider how remarkable must be the combination of circumstances conducing to the mineralisation of those relics, and their preservation to a remote antiquity; and if we reflect upon the remoteness of the probability of organisms, when buried and preserved by fossilisation, being exposed at the surface and found by man—we shall be on our guard against regarding the thousands and hundreds of thousands of beautiful fossils which are displayed in our museums, as representing more than a very small fraction indeed of the forms of life that have once existed on the globe" (pp. 442).

Part iii. deals with volcanic phenomena and products, with plutonic and metamorphic rocks, veins and metalliferous deposits. With this part of the work Prof. Judd must have felt, perhaps, the deepest interest, having made a special study for years of the volcanic phenomena of Europe, and given us in his volume on "Volcanoes" an excellent *vade mecum* which every student must possess.

It is interesting to know what line of thought Prof. Judd follows in reference to the assumed permanence of oceanic and continental areas; as this subject has greatly disturbed the minds of geologists of late years.

"From all that we know of the extreme slowness of the upward and downward movements which bring about even slight geographical changes, we may infer that it

would require a great lapse of time to cause the submarine and supramarine areas to change places, even if the ascending movements in the one region and the descending in the other were continuously in one direction. But we have only to appeal to the structure of the Alps, where there are so many shallow and deep-water formations of various ages crowded into a limited area, to convince ourselves that mountain-chains are the result of great oscillations of level. High land is not produced simply by uniform upheaval, but by a predominance of elevatory over subsiding movements. Where the ocean is extremely deep it is because the sinking of the bottom has been in excess, in spite of interruptions by upheaval" (p. 124). "Movements of 1000 feet or more would turn much land into sea, and sea into land, in the continental areas and their borders; whereas oscillations of equal magnitude would have no corresponding effect in the bed of the ocean generally, believed as it is to have a mean depth of nearly 13,000 feet. The greatest depths of the sea do not exceed the greatest heights of the land; it may, therefore, seem strange that the mean depth of the sea should exceed the mean height of the land six times, even taking the lowest estimate of the ocean depths as given by the late deep-sea soundings. This apparent anomaly arises from the fact that the extreme heights of the land are exceptional and confined to a small part of its surface; while the ocean maintains its great depth over enormous areas. It is evident that, during the recent periods of the earth's history, there have been great subsidences and elevations of the land; many raised beaches are 1000 to 1200 feet above sea-level. Dana, following Darwin's theory of atoll formation, terms the atoll a memorial of a departed land, and considers that the great Pacific subsidence was contemporaneous with the post-glacial upheaval in the north" (p. 123).

The volume concludes with three brief appendices, giving (*a*) a useful account of the common rock-forming minerals, (*b*) a classification of plants, and (*c*) of animals, both living and fossil.

The name of each mineral is conveniently printed in blacker type than the rest of the text, so as more readily to catch the eye. The names of the extinct orders of plants and animals are similarly printed in blacker type.

In appendix (*c*) there are a few errata, which should be corrected in a future edition. For instance, the worms of various kinds appear under two headings; nine orders being arranged in Series V. (p. 609), under Annuloidea, and four other orders have crept into Series VIII. under Arthropoda (on p. 610). On the same page "May-flies" are given as an example of Orthoptera instead of *Blatta* or *Mantis*. The Phyllocarida (represented by *Nebalia*, *Ceratiocaris*, &c.) have been accidentally omitted; also Schizopoda and Cumacea.

In the Reptilia, Proterosauria and Procolophonia are left out; and for Orthopoda, we would suggest Ornithopoda (bird-footed) as more correct. For Odontornæ (p. 612) read Odontormæ. Under Mollusca (on p. 609), by using the terms Gastropoda and Pulmonata, the student is in danger of supposing that snails are not gasteropods, whereas the Pulmonata are only a *subdivision* of the Gasteropoda.

We have only referred to this last appendix because it is stated (on p. 612) that the classification followed is that of Huxley, E. T. Newton, and Zittel; but no one would for a moment wish these authors to be held responsible for misprints which have accidentally crept into the table in its present form.

It is to be regretted that the classification of the fishes followed by Prof. Judd, is that of Prof. Zittel, which is now considerably modified by the later arrangement (1896) of Mr. Arthur Smith Woodward. In this latest work we find that *Pteraspis*, *Cephalaspis*, *Pterichthys*, &c., are placed in a distinct division of armoured notochordal animals, the Ostracodermi; while the old division Placodermi, is broken up; the Arthrodira (*Coccosteus-like*-fishes) alone remaining. In a similar manner the Actinopterygian order has replaced the old order Ganoidei, which has disappeared.

We have already spoken in commendation of the great abundance and excellence of the illustrations (more than 700 in number) which adorn the present work; we may, however, venture to take exception to the figures of *Cephalaspis Lyelli* (p. 380) and of *Pterichthys* (p. 382). Page's figure should be replaced by the careful restoration by Prof. Ray Lankester, and Hugh Miller's *Pterichthys* by Dr. R. H. Traquair's elegant and accurate figures of that remarkable genus.

Time and space alike preclude us from doing fuller justice to this excellent text-book; but we feel assured it will live on and be read not only by many geological students, but by a large section of the English public who still hold the name of Lyell in high estimation and value his teachings. Thus will this little volume serve to keep alive the memory of one who was, perhaps, the greatest geological writer and expositor of this century.

BOULENGER'S CATALOGUE OF SNAKES.

Catalogue of the Snakes in the British Museum (Natural History). Vol. III. Containing the Colubridæ (Opisthoglyphæ and Proteroglyphæ), Amblycephalidæ, and Viperidæ. By George Albert Boulenger, F.R.S. Pp. xiv + 727, 25 plates. (London: Printed by Order of the Trustees, 1896.)

WITH the issue of the present volume Mr. Boulenger completes his examination and description of the herpetological collections in the British Museum, which have occupied his attention for more than fourteen years. The whole series of Catalogues thus brought to a conclusion consists of nine volumes. Two of these, issued in 1882, are devoted to the Batrachians, with the study of which Mr. Boulenger commenced his labours in our National Museum, three to the Lizards (1885–87), one to the Rhynchocephalians, Chelonians, and Crocodiles (1889), and finally three to the Snakes. The enormous series which has thus been examined, classified, and catalogued consists of 38,086 specimens. These have been referred by Mr. Boulenger to 3905 species, while 1265 others, which are allowed by the author to be valid, but are not represented in the British Museum, raise the total number of known species of Batrachians and Reptiles to 5170. While it is thus evident that our great National Institution is not without its deficiencies, there can be no doubt whatever that as regards its herpetological collections, when compared with similar institutions on the continent and elsewhere, it stands absolutely unrivalled. The collection of Reptiles and Batrachians at South Kensington is "not only the largest but also the best arranged in existence, every specimen of it having been carefully examined and classified according to a modern

system after consultation of the whole literature of the subject." Moreover, the so-called "Catalogues" are not mere lists of specimens, but, as we are assured by the Director in his preface to the last volume of the series, are "complete monographs of the groups of animals treated of, so far as their zoological characters, geographical distribution and synonymy are concerned, descriptions being given of every species regarded by the author as valid, whether represented in the Museum or not." It is not too much to say that no more arduous or more important piece of zoological work has been brought to a successful issue, in modern days, than that which has been thus accomplished by the unremitting devotion of the author of these Catalogues to his task during the past fifteen years.

With regard to the Ophidians or Snakes, which are more immediately the subject of the present notice, Mr. Boulenger has had a specially difficult subject to deal with. Next to the Lizards the Snakes are the most numerous Order of Reptiles. But while the Lizards present many well-marked characters for their division into subordinate sections, the great mass of Snakes belong essentially to one extensive group which Mr. Boulenger allows only to rank as a family. Out of the whole number of 1639 species of Snakes recognised as valid in the present work, upwards of 1250 species are referred to the Colubridæ. The proper treatment of this family is one of the most embarrassing questions for the Herpetologist. The formerly recognised division of Snakes into Venomous and Non-venomous is altogether discarded by the author, who takes the structure of the skull and other anatomical characters as his guide. The great family Colubridæ embraces venomous as well as innocuous species; indeed, the poison of some of the Proteroglyphous Colubrines (such as the Cobras and Hydrophids) is quite as deadly as that of the Vipers and Rattlesnakes. In another work, recently published, Mr. Boulenger has spoken as follows upon this subject :—

"A general desire is felt by those not well acquainted with Snakes to be able to distinguish at a glance between harmless and poisonous forms. To meet this requirement various criteria have been proposed, none of which, however, are satisfactory. It is well to state at once that there is no sure method of distinguishing the two forms by external characters, except of course a knowledge of the various forms. And even then a cursory examination is not always sufficient, since there is, in some cases, a striking resemblance between Snakes of totally different affinities, by which even specialists may be at first deceived. In short, nothing but an examination of the dentition can afford positive information as to the poisonous or non-poisonous nature of an unknown Snake."

Mr. Boulenger divides the Ophidians as a whole into nine families. He commences his systematic arrangement with the small worm-like Typhlopidæ, which pass their lives in burrows beneath the earth. They are numerous under the tropics, upwards of 100 species being already known, and many more in all probability awaiting discovery. The allied family Glauconiidæ, of which twenty-nine species are registered, has similar habits. Next to these come the Boas and Pythons (Boidæ) with sixty-six species, amongst which are the monsters of the Ophidian Order. *Python reticulatus*, of the Malay countries, is said to attain a length of thirty feet, and the Anaconda of tropical forests of South America to arrive at still larger dimensions. Of the small family Ilysiidæ, which is intermediate between the Boas and the Earth-snakes (Uropeltidæ) only five species, belonging to three genera, are known, two of these being East Indian, while one, strange to say, is South American. The Uropeltidæ, on the other hand, offer us an example of an extremely limited distribution, the whole of the forty-two known species being restricted to the mountains of Ceylon and the Indian peninsula, where they are frequently dug up in the plantations of Tea and Coffee. The sixth family of Snakes, according to Mr. Boulenger's system, consists only of the anomalous *Xenopeltis unicolor*, of India and the Malayan countries, while the seventh family, the Colubridæ, as we have already mentioned, is by far the most numerous of all, containing, in fact, more than three-fourths of all the known species of Ophidians. Mr. Boulenger divides this enormous "family" into "three parallel series"—Aglypha, Opisthoglypha, and Proteroglypha. The first of these, with solid teeth, are harmless; the last, with the anterior maxillary teeth grooved or perforated, are venomous; while the Opisthoglyphs, with the posterior maxillary teeth grooved, are all to be suspected, and usually more or less poisonous. The highly venomous Proteroglyphs are followed, although they do not lead into the typical venomous Serpents with erectile maxillary, which Mr. Boulenger unites into one family—Viperidæ—classing the Pit-vipers and Rattlesnakes only as a distinct sub-family. This is his ninth and last group of Ophidians. Between it and the Colubridæ, he locates as an eighth family the Amblycephalidæ, the members of which have but little power of expanding the mouth, and feed on insects and other small prey. Of Amblycephalidæ, thirty-four species are characterised and referred to five genera.

Whatever objections may hereafter be taken, and in some cases perhaps maintained, against Mr. Boulenger's rather revolutionary scheme of the classification of Snakes, there can be no question that his "Catalogue" makes a most distinct and remarkable advance in our knowledge of these animals, and will in future be employed by herpetologists all over the world for the arrangement of their collections, and as a solid base for future research. In the case of the "Catalogue of Birds," now nearly brought to a completion in the same zoological workshop, it has been found necessary to employ many different authors whose discordant views result in a somewhat incongruous whole. But herpetology has been more fortunate than ornithology in finding a naturalist of conspicuous ability and untiring patience who has achieved the feat of arranging and classifying all the subjects under his charge upon a uniform system.

THE MANAGEMENT OF PUBLIC WORKS IN THE UNITED STATES.

The United States Public Works Guide and Register. By Captain W. M. Black. Pp. vi + 276. (New York: Wiley and Sons. London: Chapman and Hall, 1895.)

THE public works of the United States are in charge of officers working under different bureaus of the executive departments of the Government. All harbour,

river, and dock works are carried out by the Government; the department charged with this work being under the command of a chief engineer, who, with a small staff, has his headquarters at the seat of Government; the other officers of the corps being stationed throughout the country wherever their presence is required. In the same way the lighthouses, buoys, and sea marks are under the charge of a Government department, the chief of which is the Secretary of the Treasury; the other members of the Board consisting of two officers of the Navy, two of the Corps of Engineers of the Army, two civilians of scientific attainments, with an officer of the Army and one of the Navy as secretaries. The coast is divided into districts, each under the charge of an engineer. All works in connection with fortifications and defences and military engineering are managed by the department of the Secretary of War. The quartermaster's department takes charge of all stores, transport, and military buildings; and another officer of the War department has charge of all public buildings and parks.

For the guidance of the officers of these several departments a code of regulations is drawn up as to the management and conduct of contracts, and of works performed by the department. This code provides that "the importation and migration of foreigners and aliens under contract or agreement to perform labour in the United States is forbidden." That, except in cases of extraordinary emergency, the services of labourers and mechanics employed on any public works are limited to eight hours in the day. Legal holidays for employés of the Government are January 1, February 22, July 4, and December 25. Day-workmen are paid for these days, and for such other days as may be designated days for national thanksgiving by the President. The first Monday in September, known as "Labors Holiday," is a legal holiday. In the case of contracts, all persons tendering are to be notified of the time when the tenders are to be opened, and may be present, either in person or by their agents. Any officer or agent of the Government, or any member of Congress, who receives money or other bribe in connection with any contract or work, is deemed guilty of misdemeanor, and is liable to imprisonment for a period not exceeding two years, and to be fined a sum not exceeding 10,000 dollars.

The design of Captain Black's book is to show the prescribed business methods of those of the executive departments which principally control the Government work, and to describe the nature of the works and the plant and materials most frequently required. The general laws and regulations under which all the public works are carried on are given; also a description of the departments, and of the works executed by them. Engineering principles are not dealt with, but there are numerous descriptions of works, with their cost, and illustrations of the plant used, and the method of carrying them out. These include fortifications, sea and lake shore protection works, river training works, lighthouses, public buildings, &c.

It is the practice of the Works Department of the Corps of Engineers to issue annually full reports of all works going on in the several departments. These reports are often fully illustrated, and contain numerous details as to contracts entered into, cost of the work, and results attained. Any one who is familiar with these, will at once recognise that the contents of the book are largely taken from them. This, however, in no way detracts from its value.

Although the book is written for and would be of great service to engineers in the United States, it yet contains a great deal of information respecting the works carried out in that country in training and improving rivers; and the various methods of dredging in use and the cost, and also as to the works for lighting the coast, which would be found useful and instructive to English engineers. "Suction" dredging has been much more largely used in the United States than in this country, whether as applied to the removal of sand or of clay and harder material. The methods used for disintegrating hard material, and either pumping it up by centrifugal pumps or pulsometers, or by a vacuum chamber, is fully described. In the latter case, steam is admitted to a cylinder or vacuum chamber, then condensed with cold water, the vacuum formed causing an inrush of the materials to be raised through a suction-pipe; this material is then driven out through the discharge-pipe by the admission of the steam. As an illustration of the nature of the materials this method of dredging is capable of dealing with, it is stated that a 1300 lb. stone was picked up and forced through the pipes on one occasion, and on another an iron safe measuring 25 inches by 16 inches by 14 inches.

OUR BOOK SHELF.

Wild Life of Scotland. By J. H. Crawford, F.L.S. Pp. 280. (London: John Macqueen, 1896.)

Pastoral life has charms for a large proportion of the reading public, if one may judge from the quantity of literature dealing with its scenes and events. Perhaps the strain under which men now work in cities, has resulted in a reaction in favour of a return to nature. Certain it is that there is a demand for simple papers on subjects of outdoor natural history; and though much of the supply to meet is not above criticism, still the taste for descriptions of rural scenes and wild nature is well worth cultivation. Mr. Crawford has a passion for wild nature. He would like to rehabilitate some of the isolated hills and woodlands of Scotland with the reindeer, beaver, and wild boar; but the general opinion of his correspondents appears to be: "We cannot afford to grow wood for beavers to gnaw, or for boars to whet their tusks on." To see nature at her best in Scotland, he has gone away beyond enclosures, and has observed and judged of her ways for himself. This collection of papers, which represent the result of his observations and meditations, are typical of the forms of life in the woods and waters of Scotland; they are pleasantly written and attractively illustrated, and will interest all country naturalists.

A Cosmographical Review of the Universal Law of the Affinities of Atoms. By James Henry Loader. Pp. 93. (London: Chapman and Hall, Ltd., 1896.)

It is a little difficult to understand the theory presented in this book. To do justice to the author, and at the same time enable readers of Nature to appraise the contents at their proper value, we give a few extracts. It is stated that men of science have concluded "that all space must be composed of an element extremely rarefied, and that element they denominate ether." Having accepted this opinion himself, the author infers that the ether is "the primary essence of all matter, whether in a gaseous

liquid, or concrete form," which inference leads to a conclusion that seems to contain the gist of the theory advanced, and is expressed as follows. "Therefore it is reasonable to assume that this ether is composed of atoms in their normal and most rarefied state, distinct and varied in species as to their nature and substance, are unchangeable and undestructible, involved by forces of affinity from ether to a density (*sic*), and finally into a gaseous, liquid, or concrete form. And as all matter known to us is capable of being rendered volatile, either by the action of heat or potent dissolving alkalies, they are dissolved again in the course of eternity from concrete to ether." The author applies this principle of "Ether thou art, and to ether shalt thou return," very comprehensively, taking in such diverse subjects as "Nebulæ resulting in Solar Formations," "The Phenomena of the Magnet and Aurora Borealis," "The Survival of the Fittest in Protoplasmic Organisms," "Mind of Mankind," and "Rise and Fall of Nations." He also discourses freely upon "free calorics" and "latent calorics," which apparently play an important part in the scheme of involution and devolution set forth.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Position of Science at Oxford.

MAY I be allowed, as one who has had some experience both within the University itself, in more than one capacity, and also in one of our public schools, to offer a few remarks on this subject?

Your recent article states that the failure of the Science School at Oxford is not complete because "it has long been recognised that the attainments of the limited number of scientific men which it turns out compare well with those of men who have been educated in other places"; while in a subsequent passage we read: "The Science School at Cambridge has acquired such a prestige that the best boys go there, and only the second best to Oxford." These two statements are either mutually opposed, or the teaching at Oxford is of so high an order that while there the "second best" are made capable of favourable comparison with those "best boys" educated elsewhere "Failure" is hardly an apt description of such an achievement. In my opinion Oxford gets its full share of "best boys." I can quote instances of boys of second-rate ability who have gained scholarships at Cambridge, but would have failed to do so at any college at Oxford. The standard required by Oxford is undoubtedly a higher one than that which is sufficient at many (not all) Cambridge colleges; and, as a rule, the value of Oxford scholarships is correspondingly greater In my experience the character of the Final Honour Schools of Science at Oxford is such that a boy of brilliant attainments and originality is more benefited by the course there prescribed, than by the wider but shallower training of Part I. of the Science Tripos. It is my practice to endeavour to send such boys to Oxford, and hitherto there has been no cause for repentance. The prestige of the Cambridge Medical School is undoubtedly a great obstacle to the increase in numbers (if indeed this is to be desired) of science students at Oxford. London and Cambridge practitioners far outnumber all others, and it is to one of these that the parents of boys who give evidence of scientific tastes, turn for advice regarding their sons. Can it be wondered that the advice given is generally in favour of some school other than at Oxford? Until the general public realises that, alike in pure science and in medicine and surgery, Oxford can and does hold her own with other places of education, the number of Oxford students will remain small.

I believe, however, that many staunch friends of Oxford hold with me, that a small school of high standard is more in accordance with her best interests, than a large one in which applied science stifles the acquirement of knowledge for its own sake.

You pronounce, on the whole, against Greek as a compulsory subject. Does any scientific man who has learnt, be it never so little, Greek, regret the time spent upon it? In teaching elementary science, especially biology, it is brought home to the teacher that technical terms form a serious stumbling-block to many boys; but if the classical derivation of these words is mentioned, they at once cease to be difficulties, and become readily familiar. The Greek language is called into service in so many of these modern terms, that ignorance of Greek cannot fail to materially increase the obstacles that beset the path of the beginner. This is perhaps a low ground on which to argue in favour of Greek, but it is one that is too frequently entirely overlooked by its opponents.

"On the whole, the teaching in public schools is bad." One of the accused can hardly reply impartially to such a charge, but I fully agree with the half-acquittal implied in the subsequent query: "Are the public schools altogether to blame?" Science labours under heavy disadvantages at most public schools. The *genius* of the schools is classical. The value attached to science is so small, that even a promising boy cannot make up by his science for deficiency in classics or mathematics, and thus is condemned to pass his days in the lower part of the school; whereas the acute classic, however obtuse in science, is in no way hindered on his path to the sixth form. Promotion is on the aggregate of marks, and the proportion allotted to science is insignificant. Classes are arranged by aggregate merit, and a graduated series of science classes grouped according to scientific ability is almost unknown. A scientific subject added to responsions would probably improve matters; but it must be remembered that some minds are so constituted (I speak from experience and mature conviction), that scientific subjects are to them of no educational value whatever, and a compulsory examination in science would prove an impediment to many a brilliant classic whose progress we should do ill to bar. If, however, such an examination were to act in a downward direction, and cause public schools to include science in their entrance and scholarship examinations, it would indeed serve a good purpose. Few preparatory schools include science in their curriculum; their whole energy is devoted to those subjects which will bring a substantial return of advertising value in the form of a scholarship. Experience has shown me in an unmistakable way that boys who have gone through the entrance scholarship mill have, in most cases, had all aptitude for science crushed out of them, and that they require a course of mentally-invalid treatment before any of them recover a healthy tone and attitude of mind towards a subject of which they have been hitherto kept in ignorance These boys are presumably the pick of their contemporaries in general ability, and at present these keener intellects are debarred from exercise in scientific subjects, for which assuredly some few would exhibit a preference.

In a guarded expression you give your vote to the study of physics and chemistry in schools. This view is one very generally held; but I believe it to be wrong, and an inversion of the natural order. Our object, I take it, is to draw out and develop in our pupils those talents that they severally possess. Boys are outdoor beings, and they should be so; nearly every boy at some period of his life collects insects, bird's eggs, or flowers. It is this collecting instinct which ought to be converted by education into the observing habit, and so made a natural foundation on which to erect a truly scientific superstructure of acquired knowledge. More boys are interested and intellectually stimulated by subjects touching on natural history than by physics and chemistry. These last not infrequently repel at first, whereas the others can to a certain extent be pursued on the play-fields and in the surrounding country. The pupil soon finds that he must acquire some knowledge of physics and chemistry; and the want being felt, the task is more willingly undertaken. In this connection I must state my belief that the present style of examination for science scholarships at both Universities does not give sufficient opportunity to the "boy naturalist," and indeed the majority of boys who become scholars are not "naturalists" in any sense Many colleges have in this respect materially improved their examinations recently, and the change is beginning to bear fruit; but until it is more widely recognised that the boy naturalist is the parent of the man scientific, so long will many minds, by nature best suited to extend our knowledge, be diverted into unnatural and less fertile channels. OSWALD H. LATTER.

Charterhouse, Godalming, July 13.

In your issue of July 9 there is an article on "The Position of Science at Oxford," and though I am not very well acquainted with that position, and am entirely in sympathy with the writer in his endeavour to get that University to encourage the science student more than it does, yet there are some remarks in the article to which I must take exception.

The statement that men of a year's standing at Cambridge, who come up with a moderate acquaintance of science, have an opportunity of bringing themselves up to scholarship standard at the end of their first year, sounds rather as if this was of importance in attracting the science student to Cambridge. But is this opportunity really of importance? Do many men in reality get scholarships in science at the end of their first year? Is not the scholarship money rather used in increasing the value of the scholarships already gained, than in forming new ones? Are not those who go up with "a fair general education and only a moderate acquaintance with science," more often advised by their college tutor to go in for the general examination than to specialise in science at once?

But after making the above statement, unsupported by statistics, the writer goes on to make an onslaught on science teaching at our public schools as the cause of the inferiority of the science student at Oxford.

Taken as a whole, he says the science teaching at our public schools is bad. The arguments he brings forward to support this statement are that, firstly, the inducements offered to learning science are very few; secondly, it is openly discouraged; and thirdly, boys neglect those studies which may safely be neglected. He seems to try, moreover, to prove the absence of good science teaching by the fact that the average boy comes up to the university destitute of scientific ideas. Let us take these points separately. The teaching is bad because the inducements to learning science are nil. This will be news to many who spend their lives in teaching science. What are the inducements to learn anything? At an early age two, at least, of the inducements to learn are interest and fear. Now the interest taken by the average boy in learning about the things around him—the earth, the air, plant or animal life—is undeniable, and it is far easier to get him interested in events which occur in the natural world than in G.C.M. or *Mensa*. While if fear is to be called on as an inducement, it is as easy to cane him for not doing his science work as it is to cane him for neglecting his classics. But later in life a boy begins to think of his future; and if he chooses a career in which a knowledge of science will help him, it will be just as great an inducement to work hard at science as it would be to work hard at classics if he had chosen a career in which classical learning was of importance. Still later he may learn to look at learning for its own sake, and he will feel that if he has a bent towards science, he will be able to educate himself by working hard at science, just as if he had a bent towards any other study he would be induced to work hard at that particular study. So that the statement that the inducements offered to the study of science are very few, is a somewhat extraordinary one to make.

Secondly, the statement that learning science is openly discouraged is, happily, becoming a false one. There are few of our public schools now that are not doing a great deal of science teaching; and though it is to be hoped that science teaching will spread still more, yet one must gladly acknowledge the enormous advance of science teaching during the past decade, and must feel that the open discouragement of science is now no longer in existence.

But what shall be said of the argument that the product of public school science teaching is a failure because boys neglect those studies which may safely be neglected? This is a direct attack on the science teachers at all our public schools as being inefficient teachers, and is an argument for calling on all headmasters to dismiss their present staff of science teachers. Before accepting this conclusion it would be of interest to know who your correspondent is, that one might know what sort of authority he speaks with, and what knowledge he has of the science teaching at the public schools. Moreover these schools, with their absence of inducements to learning science, and their absence of efficient teachers in that subject, send science scholars in large numbers to Cambridge.

But the final argument that science teaching at the public schools is bad, is because the average schoolboy comes up to "the University" destitute of scientific ideas. There is no clue to what he means by "the University"; but, taking Cambridge as an example, a considerable percentage of its undergraduates who go in for an honours degree, take up the Natural Science Tripos, a large number go in for medicine, and others go in for the study of science in order to get an ordinary degree. Most of these have done a considerable amount of science at school, and cannot be said to be destitute of scientific ideas. But many of the others, who go in for classics, mathematics, or other studies, although they may not remember the equation representing the action of sulphuric acid on chalk, yet, if they have been taught elementary science in their youth, may have learnt from it some of the accuracy and method which should characterise their work in any direction; while the training given to the mind in forcing it to appeal from written words or spoken statements to experimental facts is of immense importance, even though the particular facts may themselves be forgotten.

But the cry that Oxford is not attracting the science student in large numbers, is no doubt true; and the reason is to be sought inside, not outside, her walls. Cambridge, it is confessed, is not in the like predicament; and Cambridge has attracted many, who would not otherwise have gone to a university at all, by her medical and engineering schools.

A vast number of boys who do science at school, go straight to the hospitals or to technical institutions; and if Oxford is to attract the science student, she must develop that side of her teaching.

C. I. GARDINER.

Cheltenham College.

Capture of a Specimen of "Lepidosiren" in the River Amazons.

I HAVE just received a letter from Dr. Émil Goeldi, Director of the rising Museum at Pará, in which he informs me of the interesting discovery of *Lepidosiren* at the mouth of the river Amazons (or rather of the river Tocantins). I had better give the part of his letter which refers to this capture. The letter is dated Pará, June 9.

"I have the pleasure of informing you of the discovery of *Lepidosiren* at the mouth of the river Amazons, viz. on the island Marajó. This afternoon I received, from a friend who has large possessions in the island, a specimen in spirits. The mail leaves in a few hours, so that I can scarcely do more than send you a few lines announcing this fortunate event.

"Often, since my arrival in Brazil, has my attention been directed to the search for this Dipnoan, especially by Prof. Karl Vogt and yourself. But it was only after my appointment to the Pará Museum, that I could take up the matter with a reasonable hope of success. I began with distributing thousands of copies of Natterer's figure in reduced size all over Amazonia, and sending paragraphs to the local newspapers in the interior. No local magistrate, no village schoolmaster escaped a notice.

"In consequence of this propaganda I received about a year ago a communication from Dr. Vicente Chermont de Miranda, who takes a great interest in all scientific matters; he informed me that the fish occurs in Marajó, and that he had seen already two specimens. The specimen sent to me now is therefore the third which has come under his notice. It measures, in the present state of preservation, about 58 cm., and is of a slate-colour. The ovaries are well developed, and show that the specimen was killed close to the spawning-time. No villi on the hind-limbs; vent asymmetrical, on the left side; greatest width of body 7 cm. Well acquainted with Ehlers's and Lankester's papers on *Lepidosiren paradoxa* and *articulata*, I looked immediately to the structure of the fin-cartilage. Its segmentation can be seen even without removing the skin, as figured in Lankester's memoir (Fig. 4). Therefore, our Amazons-specimen might be called *articulata* on the same ground as the Paraguay specimens collected by Bohls. But I agree with you and Prof. Lankester that there is one species only of *Lepidosiren*, viz. *L. paradoxa*—*L. dissimilis*, *gigliona*, *articulata* being synonyms.

"The exact locality for our specimen is Fazenda 'Dunas,' on Cape Magoary, Island of Marajó.

"One word more: Prof. Lankester speaks of five Amazons-specimens in European museums. I believe there are six. Only a few years ago the late Mr. Gustav Toepper obtained a specimen near Itaituba on the Tabajóz River which, as I have been credibly informed, has found its way into the Berlin Museum."

ALBERT GÜNTHER.

Eskimo Throwing-Sticks.

I SEND you herewith a drawing of a throwing-stick which was brought to Washington by Captain John Rodgers, U.S.N., of the *Vincennes*, who explored the Behring and the Arctic Seas from 1850–55.

In my paper on the "Throwing-Stick" (Rep. U.S. National Museum, 1884, pl. vi.), this is figured as the Rodgers specimen, locality unknown. Subsequently, M. Adrien de Mortillet produced in the *Revue Mensuelle de l'École d'Anthropologie* (viii. p. 246) a figure of a similar apparatus. Since then Mr. Walker Clark, of Edinburgh, Scotland, has sent me photographs of the same type from the Edinburgh Museum, and apparently associated with Beechey's explorations.

Dr. Franz Boas calls my attention to specimens of the same type in the American Museum in New York. The U.S. National Museum has also similar objects collected by Mr. Jas. G. Swan and the Rev. Vincent Colyer.

I have ascertained, by searching the records, that Captain Rodgers touched at Unalashka and collected specimens at that

place belonging to Kadiak, Cook's Inlet, and Prince William's Sound. Putting all the information together it is now my opinion, confirmed by that of Dr. Boas, that all of these examples are from Prince William's Sound. This belief is confirmed also by the fact that these are the only Eskimo throwing-sticks which show carving in relief on the back. They seem to be all made of hard spruce, and by their markings to be allied to those of the more elaborately carved specimens from Sitka in the British Museum, the United States National Museum, and elsewhere. The front or top side of the specimen has a fine ivory point for the butt end of a delicate sea otter, barbed harpoon, and a shallow groove only half its length. The finger pocket does not extend quite through to the top side.

OTIS T. MASON.

U.S. National Museum, Washington, June 25.

The Salaries of Science Demonstrators.

THE enclosed fable, possibly from a missing edition of Kingsley's "Water Babies," seems to have some remote connection with the heading that has been affixed to it. O. J. L.

An aggrieved tadpole once found its way as a deputation to Mother Carey, and complained as follows, at first reading from a document, but afterwards becoming more eloquent and expressive :—

"We, your industrious and not unworthy subjects, desire to lay before you our wrongs. We cannot get out on to the land and attend meetings as the frogs do, and consequently we get no flies; yet it is we who do all the work of the pond. The frog only looks in now and then; and even if he had a mastermind (which he hasn't), his visits would have no effect. He croaks, that's what he does; he sits on the bank and eats flies, and he croaks, and so he gets listened to. As for us, we are treated no better than sticklebacks or minnows; why, there's a bloated travelling newt, who gets twice as much as we do. It's all because you old fogies are accustomed to croak yourselves. It's all—— "

"And what prospects have the minnows and sticklebacks?" here interrupted the dame. "When do they hope to leave the pond and gain advancement?"

"Why, never, of course; they've got all they'll ever get, and too much at that," grumbled the tadpole.

"And do you also intend to remain in your present condition always?"

"Not I; I intend to become a frog, and hop about, and attend meetings, and catch flies, and make a noise in the world."

"Yes; and, meanwhile, you would like these desirable appurtenances of the frog state diminished? Remember your whole pond is but a recently banked-up affair—on rather sandy soil, and the margin is narrow; it might run empty unexpectedly, you know."

"I don't care," ejaculated the tadpole; "cut off the water, and then we shall all be on dry land together; anything better than the present inequality."

"Very well," said the dame; "I know some creatures in a state of probation, not long out of the egg, who actually have to pay for the privilege of practising their future career. However, your wish that one of the recently-dug supply channels shall be stopped, so that your pond may run dry enough to let you also touch solid land as your predecessors have otherwise done, is so simple and easy to carry out, that perhaps it can be managed. Fare thee well."

A Curious Rainbow.

WHILST enjoying a general survey of the sky this evening I was giving my attention more particularly to an expanse of brilliantly white cirrus cloud, unusually complicated in its detail, when, at 7 p.m., a small inverted rainbow suddenly became apparent along the front margin of this cloud (now approaching the zenith from W.S.W.).

The bow, at first, just spanned the width of the cloud upon which it was projected, but as it increased its length a little at its "left," or south-western extremity, and as the cloud drifted slightly to "right," or north of eastwards, the bow was at last wholly projected upon a background of (apparently) clear blue sky. This last effect was extremely beautiful; the bow being so brilliantly coloured that it would, I think, hardly have escaped my notice, even if I had not first seen it upon the background of white cloud.

There was a perfect sequence of all the prismatic colours from the red, below, to the violet, above—and the curvature of the bow was remarkably rapid—and extending not more than about 2° in length.

It remained visible for about 5 or 7 minutes.

If any one can furnish me, through the medium of your columns, with an explanation of this peculiarly beautiful phenomenon, and in language that can be "understanded of the people," I shall be greatly obliged. C. O. STEVENS.

Barnet, July 12.

Effect of Lightning.

ON Tuesday, July 7, a violent storm passed over this district, and three balls of fire have been reported. Two trees were splintered, and two sheep were struck by lightning on the downs.

One sheep was not seriously injured, but the other was killed; on being struck, both sheep turned over on their backs. The one fatally injured was struck on the top of the head, the lightning passing down the animal's right jaw on to its breast; here it divided into three, and passed down both fore-legs and under the stomach. The course of the lightning on the wool was like the track of a red-hot poker. After death the aft part and belly of the sheep were greatly distended, as if with air. The blood appeared to have rushed from the head to the rear of the animal at the moment of death, for, on skinning the sheep, the neck part was found to be destitute of blood, whilst a considerable amount of blood was under the skin of the back, as if blood had escaped to that position. The sheep's mouth was distorted by being drawn aside. Close to the sheep's fore-feet a hole was made in the ground by the lightning, about the size of a quart jug. WORTHINGTON G. SMITH.

Dunstable.

A Brilliant Meteor.

I HAD the pleasure on Friday evening last, the 16th inst., of observing a brilliant meteor from a point about half-way between the towns of Blaenau and Llan Festiniog. The time was 9.10 p.m., the sky quite clear, and not dark enough for any stars to appear. The meteor appeared almost due south of my position, the length of its path being an arc of about 20°, disappearing a short distance above the horizon, and lasting about four seconds. Very little trail could be seen, as it was practically daylight. The colour appeared of a bluish tinge, and the meteor appeared to become brighter in the middle of its path.

C. H. H. WALKER.

County School, Blaenau Festiniog, July 19.

THE INTERNATIONAL CATALOGUE CONFERENCE.

THE preliminary proceedings of the Conference organised by the Royal Society to consider the preparation and publication of an International Catalogue of Scientific Literature, were reported in last week's NATURE. The Conference was brought to a conclusion on Friday, and we are now able to give the official report of the Acta in the three languages in which it is indited. From this report it will be seen that the Conference has laid a sound basis for the greatest scientific bibliography ever contemplated. The Royal Society is to be warmly congratulated upon the initiative it has taken in the matter, and the whole scientific world will be gratified at the international spirit shown in the subjoined resolutions—a spirit which prevailed throughout the Conference.

Opening Meeting, Tuesday, July 14, 1896, 11 *a.m., at the Rooms of the Royal Society, Burlington House.*

The resolutions prepared by the International Catalogue Committee of the Royal Society to serve as a basis for discussion were taken into consideration, and the following resolutions were agreed to *nemine contradicente*:—

(12) That it is desirable to compile and publish by means of some international organisation a complete catalogue of scientific literature, arranged according both to subject-matter and to authors' names.

Qu'il est désirable de compiler et de publier à l'aide d'une organisation internationale un catalogue complet de littérature scientifique classé suivant les sujets et les noms des auteurs.

Es ist wünschenswert vermittelst einer internationalen Organisation einen vollständigen Katalog der wissenschaftlichen Litteratur zusammenzustellen und zu veröffentlichen, geordnet sowohl nach dem Inhalt alsauch nach den Namen der Verfasser.

(13) That in preparing such a catalogue regard shall, in the first instance, be had to the requirements of scientific investigators, to the end that these may, by means of the catalogue, find out most easily what has been published concerning any particular subject of inquiry.

Qu'en préparant le catalogue on aura avant tout égard aux besoins des travailleurs scientifiques afin que ceux-ci puissent à l'aide de ce catalogue trouver facilement ce qui a été publié concernant les recherches sur quelque sujet que ce soit.

Bei der Vorbereitung eines solchen Katalogs soll in erster Linie Rücksicht genommen werden auf die Bedürfnisse wissenschaftlicher Forscher, so dass dieselben mit Hülfe dieses Katalogs sich leicht in der Litteratur über irgend einen besondern Gegenstand der Forschung orientiren können.

(14) That the administration of such a catalogue be entrusted to a representative body, hereinafter called the International Council, the members of which shall be chosen as hereinafter provided.

Que l'administration d'un tel catalogue soit confié à un corps représentatif, sous le nom de *Conseil International*, dont les membres seront choisis d'après les décisions prises ultérieurement.

Die Administration eines solchen Katalogs soll einer repräsentativen Körperschaft übertragen werden (die weiterhin "the International Council" genannt wird) deren Mitglieder in einer später zu bestimmenden Weise gewählt werden sollen.

(15) That the final editing and the publication of the catalogue be entrusted to an organisation, hereinafter called the Central International Bureau, under the direction of the International Council.

Que l'édition définitive et la publication du catalogue soient confiées à une organisation nommée plus tard le *Bureau Central International* sous la direction du Conseil International.

Die Herausgabe und Veröffentlichung des Katalogs soll, unter der Leitung des International Council, einer Organisation anvertraut werden, die hier "Central International Bureau" genannt wird.

(16) That any country which shall declare its willingness to undertake the task shall be entrusted with the duty of collecting, provisionally classifying, and transmitting to the central Bureau, in accordance with rules laid down by the International Council, all the entries belonging to the scientific literature of that country.

Que l'on charge chaque pays, qui se déclarera prêt à entreprendre cette tâche, de collectionner, de classer provisoirement, et de transmettre au Bureau Central selon les règles formulées par le Conseil International, tous les matériaux necessaires pour la bibliographie de la littérature scientifique de ces pays.

Jedes Land welches sich bereit erklärt, an der Arbeit theilzunehmen, soll mit der Aufgabe betraut werden, in Uebereinstimmung mit den von dem International Council vorgeschriebenen Regeln, das Material über alle einschlägigen wissenschaftlichen Veröffentlichungen des betreffenden Landes zu sammeln, provisorisch zu klassifiziren und dem centralen Bureau zu übermitteln.

(17) That in indexing according to subject-matter regard shall be had, not only to the title (of a paper or book), but also to the nature of the contents.

Que dans le classement du catalogue d'après la nature des sujets, on aura égard non seulement aux titres d'un article ou d'un livre, mais aussi à la nature de son contenu.

Bei der Aufzeichnung der Abhandlungen und Bücher soll nicht nur der Titel derselben sondern auch der Inhalt berücksichtigt werden.

(18) That the catalogue shall comprise all published original contributions to the branches of science hereinafter mentioned, whether appearing in periodicals or in the publications of Societies, or as independent pamphlets, memoirs, or books.

Que le catalogue comprendra toutes les contributions originales aux différentes branches de la science telles qu'elles sont mentionnées ci-après, paraissant soit dans les revues, ou dans les publications des sociétés, ou comme brochures indépendantes, mémoires, ou livres.

Der Katalog soll alle Original-Abhandlungen aus den weiter unten angeführten Wissenszweigen umfassen, gleichviel ob dieselben in Zeitschriften oder in Veröffentlichungen von Vereinen erschienen sind, oder in Form von Flugschriften, selbständigen Aufsätzen oder Büchern.

Second Meeting, Wednesday, July 15, 1896, 10 *a.m., at the Rooms of the Royal Society, Burlington House.*

(19) It having been proposed—

That a contribution to science for the purposes of the catalogue be considered to mean a contribution to any of the mathematical, physical or natural sciences, the limits of the several sciences to be determined hereafter—

Que devront entrer dans le catalogue toutes les contributions aux sciences mathématiques, physiques ou naturelles, les limites des différentes sciences étant déterminées ultérieurement.

In den in Rede stehenden Katalog sollen alle wissenschaftlichen Beiträge zur Mathematik und zu den Naturwissenschaften aufgenommen werden; die Abgrenzung der verschiedenen Wissenschaften ist weiterhin festzustellen.

The following amendment was moved, and, after discussion, adopted:—

That the terms of the resolution be referred to a Committee, consisting of Messrs. Armstrong, Billings, Darboux, Korteweg, Möbius, and Schwalbe, to report to the Conference at the opening meeting, on July 16.

The following resolutions were then agreed to *nemine contradicente*:—

(20) That in each country the system of collecting and preparing material for the catalogue shall be subject to the approval of the International Council.

Que la méthode employée pour réunir et préparer le matériel du catalogue dans chaque pays sera soumise à l'approbation du Conseil International.

Es soll das System, nach welchem das Material für den Katalog in jedem Lande gesammelt und vorbereitet wird, der Zustimmung des Internationalen Ausschusses unterworfen sein.

(21) That in judging whether a publication is to be considered as a contribution to science suitable for entry in the catalogue, regard shall be had to its contents, irrespective of the channel through which it is published.

Que pour juger si une publication doit être considérée comme propre a être admise dans le catalogue, on aura égard à son contenu, indépendamment du lieu et de la forme de la publication.

Bei der Beurtheilung, ob ein Beitrag zur Eintragung in de-

Katalog geeignet ist, soll der Inhalt berücksichtigt werden, ohne Rücksicht auf den Ort oder die Art der Veröffentlichung.

(22) That the Central Bureau shall issue the catalogue in the form of "slips" or "cards," the details of the cards to be hereafter determined, and the issue to take place as promptly as possible. Cards corresponding to any one or more branches of science, or to sections of such sciences, shall be supplied separately at the discretion and under the direction of the Central Bureau.

Que le Bureau Central éditera le catalogue sous la forme de fiches, le détail des fiches devant être déterminé ultérieurement, et la publication devant avoir lieu le plus promptement possible; les fiches relatives à une ou plusieurs sciences cu à l'une des sections de ces sciences seront fournies séparément au publie sous la discretion et à la direction du Bureau Central.

Das Central-Bureau soll den Katalog in der Form von "Papierstreifen" oder "Karten" ausgeben; die Details für diese Karten sollen später näher bestimmt werden; die Ausgabe soll so rasch als möglich geschehen; Karten, welche zu der einen oder andern Wissenschaft, oder zu Abtheilungen derselben gehören, sollen mit Zustimmung und auf Anordnung des Central-Ausschusses separat verabfolgt werden.

(23) That the Central Bureau shall also issue the catalogue in book form from time to time, the entries being classified according to the rules to be hereafter determined.

That the issue in the book form shall be in parts corresponding to the several branches of science, the several parts being supplied separately, at the discretion and under the direction of the Central Bureau.

Que le Bureau Central publiera, de temps en temps, le catalogue sous le forme de livre, les titres étant classés selon les règles qui seront déterminées ultérieurement.

Que la publication sous forme de livre sera divisée en parties correspondant aux diverses branches des sciences, les diverses parties pouvant être fournies séparément, sur demande.

Das Central-Bureau soll auch, von Zeit zu Zeit, den Katalog in Buchform herausgeben und sollen die Titel nach weiterhin zu bestimmenden Regeln klassifizirt werden.

Die Herausgabe in Buchform soll in Abtheilungen geschehen, welche den einzelnen Wissenschaften entsprechen, und sollen die Theile auf Verlangen einzeln verabfolgt werden.

(24) General Ferrero having moved

That the Central Bureau be located in London—

The resolution was seconded by M. Darboux, supported by Messrs. Möbius, Heller, Weiss, Simon Newcomb, Otlet, Duka, Bourcart, Dahlgren, and Korteweg, and accepted by acclamation.

Third Meeting, Thursday, July 16, 1896, *at the Rooms of the Royal Society, Burlington House.*

The appointment of Prof. Liversidge, F.R.S., as official delegate representing New South Wales, was notified.

(25) The following resolutions were agreed to *nemine contradicente*:—

That a contribution to science for the purposes of the catalogue be considered to mean a contribution to the mathematical, physical, or natural sciences, such as, for example, mathematics, astronomy, physics, chemistry, mineralogy, geology, botany, mathematical and physical geography, zoology, anatomy, physiology, general and experimental pathology, experimental psychology and anthropology, to the exclusion of what are sometimes called the applied sciences—the limits of the several sciences to be determined hereafter.

Devront entrer dans le catalogue toutes les contributions aux sciences mathématiques, physiques, et naturelles; par exemple: Mathématique, astronomie, physique, chimie, minéralogie, géologie, géographie mathématique et physique, botanique, zoologie, anatomie, pathologie générale et expérimentale, psychologie expérimentale, physiologie et anthropologie, à l'exclusion de ce qu'on nomme parfois sciences appliqués; les limites des différentes sciences seront déterminées ultérieurement.

In den in Rede stehenden Katalog sollen alle Beiträge zur Mathematik und zu den Natur-Wissenschaften aufgenommen werden, wie (z. B.) zur Mathematik, Astronomie, Physik, Chemie, Mineralogie, Geologie, zur Mathematischen und Physikalischen Geographie, zur Botanik, Zoologie, Anatomie, Physiologie, Allgemeinen und Experimental-Pathologie, Psychophysik und Anthropologie, unter Ausschluss der sog. angewandten Wissenschaften;—wobei die Abgrenzung der einzelnen Gebiete noch in der Folge festzulegen ist.

(26) That the Royal Society be requested to form a Committee to study all questions relating to the catalogue referred to it by the Conference, or remaining undecided at the close of the present sittings of the Conference, and to report thereon to the Governments concerned.

La Société Royale est priée de créer une Commission; celle-ci sera chargée d'étudier toutes les questions relatives au Catalogue, qui lui sont renvoyés par la Conférence et celles qui n'ont pas été résolues définitivement dans la Conférence, et de faire rapport sur le sujet aux gouvernements intéressés à l'entreprise.

Die Royal Society wird ersucht, ein Comité zu bilden, mit dem Auftrag, alle Fragen, welche ihr von der Conferenz vorgelegt werden und alle welche noch nicht definitiv festgelegt sind, auszuarbeiten und darüber an die beteiligten Regierungen zu berichten.

(27) Since it is probable that, if organisations be established in accordance with Resolution 16, the Guarantee Fund required for the Central Bureau can be provided by voluntary subscriptions in various countries, this Conference does not think it necessary at present to appeal to any of the Governments represented at the Conference for financial aid to the Central Bureau.

L'organisation prévue à la résolution 16 rendant probable que le fonds de garantie nécessaire au Bureau Central pourra être fourni par des souscriptions particulières dans différents pays, la Conférence estime qu'il n'est pas indispensable pour le moment de faire appel à l'aide financière des Gouvernements intéressés.

Insoferne voraussichtlich Einrichtungen im Sinne von Resolution 16 getroffen werden, erscheint es möglich, einen Garantiefonds für das Centralbureau durch freiwillige Zeichnung in den verschiedenen Ländern aufzubringen, und es glaubt daher die gegenwärtige Conferenz dass es zur Zeit nicht notwendig für das ist Centralbureau die finanzielle Unterstützung irgend einer der bei der Conferenz vertretenen Regierungen in Anspruch zu nehmen.

Fourth Meeting, Friday, July 17, 1896, *at the Rooms of the Royal Society, Burlington House.*

The following resolutions were agreed to *nemine contradicente*:—

(28) The Conference being unable to accept any of the systems of classification recently proposed, remits the study of classifications to the Committee of organisation.

Le Conférence ne pouvant accepter aucune des systèmes de classification récemment proposés renvoie l'étude des classifications au Comité d'organisation.

Die Conferenz kann keine der verschiedenen in der letzten Zeit vorgeschlagenen Classifications-Systemen annehmen und überträgt desshalb die Ausarbeitung von Classificationen dem Organisations-Comité.

The Belgian delegates expressly desired that it be placed on record that they abstained from voting on this resolution.

(29) That English be the language of the two catalogues, authors' names and titles being given only in the original languages except when these belong to a category to be determined by the International Council.

L'anglais sera la langue des deux catalogues. Toutefois les noms d'auteurs et les titres des mémoires seront donnés seulement dans la langue originale à moins que cette langue n'appartienne à une catégorie qui sera déterminée par le Conseil International.

Es soll Englisch die Sprache der beiden Cataloge sein. Die Namen der Verfasser und die Titel sollen indessen ausschliesslich in der Original-Sprache veröffentlicht werden, ausgenommen in den von dem Internationalen Ausschuss zu bestimmenden Fällen.

(30) That it be left to the Committee (of the Royal Society) to suggest such details as will render the catalogue of the greatest possible use to those unfamiliar with English.

Le Comité aura à proposer tous les détails qui seraient de nature a rendre plus facile l'usage du catalogue dans les pays de langues étrangères à la langue anglaise.

Es wird dem Comité der Royal Society überlassen, alle Anordnungen zu treffen welche den Gebrauch des Cataloges für die nichtenglischen Sprachen zu erleichtern geeignet sind.

(31) That it is desirable that the Royal Society should be informed, at a date not later than January 1, 1898, what steps (if any) are being taken, or are likely to be taken, in the countries whose Governments are represented at the Conference, towards establishing organisations for the purpose of securing the end had in view in Resolution 16.

Qu'il est désirable que la Société Royale reçoive communication, au plus tard le 1[er] janvier, 1898, des démarches qui ont été prises ou seront prises par les gouvernements des pays représentés à la Conférence pour l'exécution de la résolution 16.

Es ist wünschenswerth, dass die Royal Society nicht später als bis zum 1. Januar 1898, darüber verständigt werde, welche Schritte von Seiten der Länder welche Delegirte zur Versammlung gesendet haben gethan oder in Aussicht genommen sind, um Einrichtungen zu treffen welche die Durchführung des Beschlusses 16 ermöglichen.

(32) That the Delegates, in reporting to their respective Governments the Proceedings of the Conference, should call immediate attention to Resolutions 16 and 31.

Que les délégués sont invités en faisant rapport à leurs gouvernements à attirer spécialement l'attention sur les résolutions 16 et 31.

Die Dèlegirten wollen in den Berichten an ihren Regierungen über den Verlauf der Versammlung, die besondere Aufmerksamkeit auf die Beschlüsse 16 und 31 lenken.

(33) That January 1, 1900, be fixed as the date of the beginning of the catalogue.

Que le début du catalogue soit fixé au 1[er] janvier, 1900.

Es soll der 1. Januar 1900 als Datum für den Anfang des Cataloges festgesetzt werden.

(34) That the Royal Society be requested to undertake the editing, publication, and distribution of a verbatim report of the Proceedings of the Conference.

La Société Royale est prié de se charger de la confection, de la publication, et de la distribution d'un compte rendu textuel des travaux de la Conférence.

Die Royal Society wird ersucht, die Abfassung, Veröffentlichung und Versendung eines wörtlichen Berichtes der Verhandlungen der Conferenz zu übernehmen.

(35) That the *procès verbal* of the Conference be signed by the President and Secretaries.

(36) That this Conference requests the Royal Society to express to the Lord Mayor of London and to Dr. L. Mond their grateful, hearty appreciation of the hospitality shown by them to the Delegates.

(37) On the motion of M. Darboux, a vote of thanks to Sir John Gorst, for presiding over the Conference and his conduct in the chair, was passed by acclamation.

(38) On the motion of Prof. Weiss, a vote of thanks to the Royal Society, for their cordial reception of the Delegates, was unanimously carried.

Signed { JOHN E. GORST, President.
HENRY E. ARMSTRONG }
WALTHER DYCK } Secretaries.
F. A. FOREL }

ARCHÆOLOGICAL STUDIES IN MEXICO.

MR. WILLIAM H. HOLMES, who has been so long and favourably known in connection with the Smithsonian Institute at Washington, has lately been placed in charge of the Department of Anthropology at the Field Columbian Museum at Chicago, and has now issued from his department the first volume of what promises to be a most interesting series of anthropological publications.

Soon after Mr. Holmes had moved to his new post, Mr. Alison Armour, of Chicago, who takes a keen interest in archæological studies, invited (to quote from Mr. Holmes's preface) a number of "gentlemen representing different branches of scientific research to accompany him in his steam yacht *Ituna* on a voyage to Mexico. Three months were spent in that most interesting country, mainly in the States of Yucatan, Chiapas, and Oaxaca. The writer (Mr. Holmes) was a member of the party, and, as Curator of Anthropology in the Field Columbian Museum, was expected to examine and describe such archæologic remains as happened to be encountered during the journey."

Mr. Holmes made excellent use of his opportunities, and we now have the first instalment of his Report, intituled "Archæological Studies among the Ancient Cities of Mexico," dealing particularly with the monuments of Yucatan.

After an introductory chapter (with excellent illustrations), which treats of the materials and methods used in construction of Maya buildings, Mr. Holmes describes in turn the different groups of ruins which were visited, beginning with those on the islands lying close to the eastern coast of the peninsula, Mugeres, Cancun, and Cozumel. An excellent reproduction of a photograph, taken by Mr. E. H. Thompson, shows the very curious portal of a small temple on the last-named island, with one of the two supporting columns formed of a kneeling human figure.

On first opening Mr. Holmes's report I turned over the pages hastily to find an account of the ruins of Tuloom, but was doomed to disappointment. On page 75 is the following paragraph: "The most important group of ruins on the east coast of Yucatan, so far as the remains have been reported, is that known as Tuloom. It is situated on a high bluff overlooking the sea, some twenty-five miles south-west of San Miguel, the main settlement of the island of Cozumel. It was visited by Stephens in 1840, and he has given us the only available account[1] published up to date. This place must have been an important stronghold of the ancient Mayas, although it was not visited by the early Spaniards, so far as our records show. It is a remarkable circumstance that this place is held to-day by a Maya tribe which has never been permanently subdued by the Spaniards or Mexicans, and which now holds it as an outpost, being at war with the Mexican Government and with all intruders, whatsoever their nationality. At the time of our visit to Cozumel there were special symptoms of hostility, and the sub-chief, to whom the Tuloom district was entrusted by the principal chief, whose headquarters are some distance inland, had recently been summarily executed for permitting trade between his people and the inhabitants of Cozumel. It was natural, therefore, when the leading citizen of Cozumel, Don Pedro Perez, assured us that we would certainly be fired upon by the hostiles if we attempted to land, that the project of studying this ruin was abandoned."

I most fully sympathise with the travellers in their disappointment in failing to examine this important site, which, as far as I know, has never since the time of Stephens and Catherwood been visited by any one capable of giving an adequate description of the ruins.

The yacht then sailed round the north of the peninsula, and the travellers were landed at Progreso, whence a land journey was taken to visit the celebrated ruins of Uxmal, Izamal, and Chichén Itzá.

Uxmal is so easy of access, and has been so often visited, photographed, and described, that Mr. Holmes could not be expected during a short visit to discover anything which would add to our previous knowledge; but the admirably clear description which he gives of the ruins is accompanied by a plan and by a most carefully compiled panoramic view of the site, which will prove of the greatest assistance to the reader.

Plate vii. gives a photograph of an inscribed column or stela discovered by Mr. Thompson, which is of the utmost value, as so very few examples of carved hieroglyphic inscriptions have as yet been found in Yucatan, and a comparison of the Yucatec inscriptions with the numerous inscriptions found in Guatemala and Chiapas

[1] Stephens' "Incidents of Travel in Yucatan," vol. i. p. 390.

is a matter of the highest interest to students of American archæology.

I trust that in a future publication Mr. Holmes will give us a drawing of the whole of the inscription on this stela, as only a portion of it is shown in the photograph.

After a glance at Izamal the travellers went on to Chichén Itzá, where they remained for a week. As I was myself encamped for five months at Chichén Itzá in 1889, engaged in clearing and examining the ruins, I am well able to appreciate the great extent and excellence of the work accomplished by Mr. Holmes during the short time at his disposal. The property on which the ruins stand has recently passed into the possession of Mr. E. H. Thompson, formerly United States Consul in Merida, who has for many years been an ardent student of Maya archæology, and amongst other work has made an exhaustive examination of the ruins of Labná for the Peabody Institute at Harvard. Now that Mr. Thompson is resident at Chichén, we may look forward to many interesting discoveries by one who has had such long experience in the field.

I can only express my regret that at the time of his visit Mr. Holmes had not yet received copies of my plans and photographs (the first portion of which has been published in the *Biologia Centrali Americana*, vol iii.), as his corrections and criticisms made on the spot would have been of the utmost value.

Mr. Holmes's work has been so well done, and must be so acceptable to all students of the subject, that I have some fear that it may seem almost ungracious on my part to note what appear to me some few errors which my longer residence in the ruins enable me to detect.

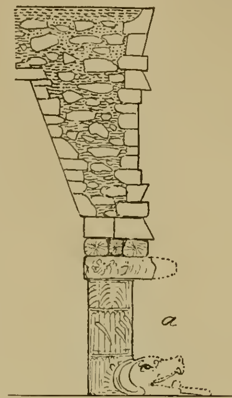
On p. 114, the mutilated figures in the niches on either side of the mask over the doorway of the "Iglesia" are not human figures, but apparently humanised animals, one being a turtle and another an alligator.

On pp. 116–117, the curious round tower known as the "Caracol," is figured and described as symmetrically placed on its double terraces; but I found the upper terrace to be curiously uneven, and unsymmetrically placed on the lower one.

On p. 119, Mr. Holmes states: "The exterior conformation of this strange tower can be made out in part only. The lower wall is of ordinary masonry, finished in plaster, and broken only by the four entrances. It rises nine or ten feet to the base of the formidable, five-membered moulding, which projects two feet from the wall face and is five feet in width, being the only example of its kind in Yucatan. The upper margin is opposite the middle of the arch slope within, as seen in the section. The masonry at this level is four feet thick.

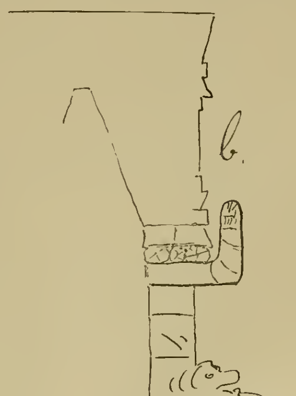
"In studying this part of the building the very interesting question arose as to whether the exterior wall surface above this moulding rose vertically or whether it sloped inwards toward the upper turret. I had the good fortune to find one vertical stone, representing the first course above the moulding, in place, and this I regard as conclusive proof that the upper wall-zone was vertical. This conclusion is confirmed by the fact that in all cases in Yucatan and Chiapas, so far as I have observed, where the upper mural zone slopes, it includes with it in the slope not only all the courses above the medial mouldings, but the medial mouldings themselves, whereas in this case the mouldings are vertical." This conclusion is of considerable importance, and shows that I have fallen into an error in my figuring of the upper part of the Caracol (*Biol. Centr. Am.*, vol. iii. plate 20), and makes me regret all the more that my plans and photographs were not in Mr. Holmes's hands when he was at Chichén.

On p. 124, in describing the "Castillo," Mr. Holmes suggests that the balustrades of all four stairways ended in serpents' heads; but this is the case in the northern stairway only. I moved many tons of earth and stones in order to uncover the base of the western stairway, and found the end of the balustrade to be without any ornament whatever. I cannot agree with Mr. Holmes in the assumption that the corners of the pyramidal foundation were ornamented with great serpents' bodies "following in and out the nine-terraced steps."[1] The structure of the



rounded corners of the pyramid can be fairly well made out at the north-east angle; but in all probability it was thickly overgrown, and so escaped notice.

In describing the portal of the Castillo, and the portal of the temple on the wall of the Ball Court (the temple of the Tigres), Mr. Holmes has just failed to catch the full structure of the serpent columns. These

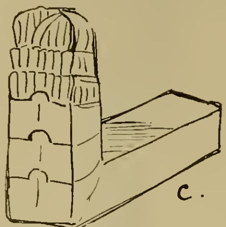


columns are markedly characteristic of Chichén Itzá, and the portals of no less than six of the temples were supported by them. One is figured in the frontispiece (Plate 1), and again in the sections of the Castillo and of the Ball Court temple. The figure here reproduced (*a*) is from the section of the Castillo (p. 123). The more correct drawing would be as in (*b*), the projection from

the capital (c) of the column, turning upwards and being carved to represent the rattles on a rattlesnake's tail, with the addition, in some instances, of a plume of feathers.

It is this peculiar form of capital which has done so much to ensure the ruin of the façades of the Chichén Itzá temples; for the weight of the projecting tail tilted the capital outwards as the wooden beam above it decayed.

Some of these queer-shaped capitals (c) can be found lying on the slopes or at the bottom of the pyramidal



C.

foundations of the temples; and it is only in the case of the Castillo, where the projecting tail has been broken off, as shown in Fig. a, that the façade of the temple has escaped destruction.

On page 132 it is stated that "the lintel beams of the doorway (temple of the Tigres), three in number, and set as indicated in the section, are covered with well-executed glyphs." For "glyphs" must be here read "ornaments," as there is no trace of any hieroglyphic inscription.

I notice that in describing the painted mural decoration of the interior of this temple no notice is taken of the picture above the doorway of a human sacrifice, and I greatly fear it must have disappeared since I traced it in its already mutilated condition in 1889.

Mr. Holmes was not able to attempt any detailed examination of the great group of colonnades and temples which lie to the east and south-east of the Castillo. These I surveyed in 1889, but had no time to make satisfactory excavations, and I greatly envy Mr. E. Thompson the opportunity he has of making a thorough exploration of these most interesting remains.

There is one point on which I hope Mr. Holmes will give us some further enlightenment. On page 102 he states, without quoting his authorities, that Chichén Itzá was occupied by its builders for nearly 200 years after its discovery by the Spaniards.

I have endeavoured to show in my own account of the ruins (*Biol. Centr. Am.*, vol. iii. pp. 5–9), that the statement that the Spaniards encamped at Chichén in 1528 must be received with caution, and neither Bishop Landa, nor the report drawn up at Valladolid in 1579, appear to me to indicate any occupation of Chichén by the Mayas at the time of the conquest, although it may still have been held in reverence as a place of pilgrimage.

Part i. of Mr. Holmes's report ends with the description of Chichén Itzá. The descriptions throughout are lucid, and the illustrations numerous and excellent. All students of American archæology will eagerly look forward to the succeeding issues, and will, I feel sure, join me in hearty congratulations to Mr. Holmes on the excellence of his work, and to the Field Columbian Museum on having thus been able to utilise his services; and all of us, who have expensive scientific hobbies, must wish that there were more Alison Armours in the world to give such splendid and timely help to scientific research.

ALFRED P. MAUDSLAY.

MEASUREMENT OF CLOUD HEIGHTS AND VELOCITIES.[1]

THE study of the form and motion of the clouds has been a favourite subject with meteorologists and physicists from the earliest times. Among the first works, since the invention of printing, may be mentioned one by J. Alkindus (Venice, 1507), dealing with clouds in general, and one on the height of clouds, by J. Bernoulli, "Nova ratio metiendi altitudines nubium" (Lipsiae, 1688). But it is only during the last quarter of a century, since it has been recognised that cyclones and anticyclones form part of the general circulation ot the atmosphere, that the importance of a systematic study of the upper air-currents by means of clouds has been fully appreciated. For this purpose various methods, both with and without instruments, have been employed. In 1878 the Meteorological Council decided upon undertaking a series of experiments at the Kew Observatory, with a view of obtaining records of the height and velocity of clouds, by means of photography, for which purpose cameras fitted with theodolite mountings, and provided with altitude and azimuth circles, were used. The results of subsequent investigations, in which the exposure of the plates was effected by electrical means, were published in the *Proceedings* of the Royal Society, vol. xlix. p. 467. In vol. viii. p. 108, of the *American Meteorological Journal*, Mr. Rotch gives an account of the measurements of cloud velocities at Blue Hill Observatory, Massachusetts, by timing the movement of shadows cast by the clouds at points whose distance apart was known. During the present year, owing to the action taken by the International Meteorological Committee, cloud observations are being made in all parts of the globe, and instructions for the use of special instruments have been drawn up, at the request of the Committee, by Dr. Hildebrandsson, of Upsala. The majority of stations, if they use instruments at all, restrict themselves to the use of simple nephoscopes, which give the direction and apparent velocity of the clouds, by means of a mirror and graduated circles; in these instruments the observations are not influenced by the effects of perspective, which are the same in the sky and in the mirror. At

some of the principal observatories theodolites and photogrammeters are being used. Each of the last two methods has its advantages and disadvantages; theodolites are simpler and cheaper, while photogrammeters require a certain amount of skill in photography. The

[1] "Wolkenhöhenmessungen," von E. Kayser (*Schriften der Naturforschenden Gesellschaft in Danzig*, 1895); "Des principales méthodes employées pour observer et mesurer les nuages," par H. H. Hildebrandsson et K. L. Hagström (Upsala, 1893).

theodolite requires the two observers—each placed at one end of the measured base—to agree by telephonic correspondence on one fixed point in the cloud, which it is not always easy to do, as well as on the precise instant at which the observation should be taken; the calculation of the observations is subsequently made from trigonometrical formulæ, or by a slide-rule, or plotting machine. The photogrammeter, which is a theodolite provided with a small telescope and a camera obscura, possesses one great advantage from the fact that the two observers have no need to agree as to the special point to be observed: it is sufficient that both photograph the same part of the sky at the same moment. On each photographic plate the coordinates of a point of intersection are known, and by placing it upon a glass scale graduated to millimetres the coordinates of as many points as may be desired can be fixed; it is only necessary to determine, once for all, how many minutes correspond to a millimetre on the plate. Once the coordinates are found, the calculations can be made as in the case of the theodolites. As these researches require the calculation of a great number of observations, it is indispensable that the methods employed in reducing them should be as simple as possible. This desideratum has been solved by M. Akerblom, in a very satisfactory manner, in a pamphlet entitled "De l'emploi des Photogrammeters"

(Upsala, 1894), which has been distributed by Dr. Hildebrandsson to intending observers. Easy methods of reduction, giving approximately correct results, have also been devised by General R. Strachey and Sir G. Stokes.

We have before us a valuable investigation by Dr. Kayser, containing some 1500 cloud measurements made under the auspices of the Philosophical Society of Danzig, between May and August 1895, by means of photogrammeters. In various respects the camera used appears to be an improvement on some of the instruments hitherto adopted, being of simple construction, well balanced, and combining ease of movement with necessary rigidity, while the altitude and azimuth circles are sufficiently large to admit of accurate reading. The accompanying plates are reproductions of a pair of photographs of a cumulus cloud observed by this means on May 25, 1895. The mean height of the cloud from several measurements was found to be 1714 metres, the distance between the two observing stations being about 679 metres. In order not to delay the publication of the Society's volume, no classification of the heights of the various clouds has been made; but in the *Meteorologische Zeitschrift* for May, Dr. Sprung has attempted this, and finds the mean values in metres to be as follows:—Stratus, 1704; cumulus, 2856; strato-cumulus, 2196; alto-cumulus, 4098; cirro-cumulus, 6834; cirrus, 10,043. The daily variation of altitude cannot be deduced from these observations, because they were not distributed sufficiently uniformly throughout the day. Dr. Kayser's work contains useful materials for the study of observers during the international cloud year, and we are glad to see that the observations are to be continued this summer.

NOTES.

On Wednesday in last week, the Queen invested Lord Kelvin with the Riband and Badge of a Knight Grand Cross of the new Royal Victorian Order.

Sir William MacCormac has been elected President of the Royal College of Surgeons of England.

General M. Rykatchef has been appointed Director of the Central Physical Observatory, St. Petersburg, in the place of Dr. H. Wild, resigned. For many years General Rykatchef has had charge of the maritime meteorological branch of that Observatory.

In the House of Commons on Friday last, Sir S. Northcote asked the President of the Board of Trade if he would introduce this Session a Bill to deal with the metric system, in order that chambers of commerce and other parties interested might have sufficient time during the recess to consider the proposals of Her Majesty's Government on this subject. Mr. Ritchie replied that he would be glad to introduce the Bill, but without any intention of proceeding with it this Session.

The large male Indian elephant which was brought home by the Prince of Wales from India in May 1876, and which died in the Zoological Society's Gardens on March 8 last, has been successfully mounted by Mr. E. Gerrard, jun. The specimen is at present placed in the Central Hall of the Natural History Museum, just opposite the principal entrance; but it will be ultimately moved to the Mammal Gallery, which is now in process of rearrangement, when space has been found for it.

A fine example of the Pangolin, or Scaly Anteater, is now on view at the Zoological Society's Gardens, having been placed there, on deposit, by the Hon. Walter Rothschild. Pangolins are seldom seen in captivity, being very difficult to keep in good health. There has been no example of this form in the Society's collection for nearly twenty years. The present specimen, which seems likely to do well, belongs to the species called the Short-tailed Pangolin (*Manis temmincki*), of which a good figure is given in the third volume of "The Royal Natural History," lately published. It is said to have been obtained in the Transvaal.

Dr. Klein recently delivered three lectures on the subject of "Recent Researches in the Identification of the Typhoid Bacillus and the Cholera Vibrio," being the Harben Lectures in connection with the British Institute of Public Health. The lectures are the property of that Institute, and will be published in its official organ, *The Journal of State Medicine*. The first lecture has just been published in the July number. The other lectures will appear in the August number.

By means of a rearrangement of existing scholarships at the Charing Cross Hospital Medical School, and by the establishment of a special fund, memorials have been founded to Dr. Livingstone and Prof. Huxley, both old students of the school. The memorial to Livingstone takes the form of an entrance scholarship of 100 guineas per annum, and that to Huxley of (1) an entrance scholarship of £55, open to the sons of medical men; (2) a second year's prize in anatomy and physiology; and (3) a lectureship dealing with recent advances

in science and their bearing on medicine and surgery. The first of these Huxley lectures will be delivered in the anatomical theatre of the Medical School on Monday, October 5, by Dr. Michael Foster.

THE Bertillon system of anthropological measurements has just been adopted at the Sing Sing States Prison.

THE 126th meeting of the Yorkshire Naturalists' Union will be held at Staithes, for the investigation of the neighbouring coast, and the Easington and Roxby Woods, on Bank Holiday Monday, August 3, 1896.

THE annual meeting of the Society of Chemical Industry was held as we went to press last week. In the course of his presidential address, Mr. Thomas Tyrer compared the German and English chemical industries, and remarked: "The real cause of the progress and prosperity of the former is to be found in the superior qualifications of the directing minds. Germany does not owe her progress alone to protective tariffs, nor to the superior discipline of her workmen, but to her thorough system of education, elementary and secondary. Dr. Seth Low's definition of a college as a place for liberal culture and a university as a place for specialisation based on liberal culture, is true of Germany, and should be so for Britain. The agitation for a teaching university for London is, therefore, a good thing. Moreover, no scheme of education will approach perfection unless it provides for the graduated affiliation of schools and colleges with universities. The City Companies and Guilds of London are taking a prominent part in supplying the great need for scientific training; and with all the resources of this wealthy country, the practicality of its people, and the public spirit of its citizens, we ought to remain very little longer in a state of educational backwardness. It is but necessary that the State shall define the need, and the steps by which that need shall be met, and then resolutely carry them out." The Council recently instituted medals to be awarded at intervals of not less than two years for conspicuous services rendered to applied chemistry by research, discovery, invention, or improvement in processes. The first award was made, at last week's meeting, to Mr. John Glover, inventor of the "Glover" tower, the introduction of which marks an important development in alkali manufacture. The newly-elected President of the Society is Dr. Edward Schunck, F.R.S.

THE naturalists of the Marine Biological Association have recently been paying particular attention to the question of the collection of fishery statistics, and an important report on the subject has just been received by the Council of the Association. In this report an account is first given of the statistics at present collected and published by the Board of Trade relating to sea-fisheries in England. It is pointed out that the methods at present adopted for collecting the statistics are not such as to give confidence in the accuracy of the returns, whilst their inadequacy in plan and extent cannot be questioned. The defects upon which emphasis is principally laid are the want of sufficient discrimination between the species of fish landed, the lack of all information as to the locality of capture of the fish, and the fact that no attempt is made to distinguish between the products of different methods of fishing. Various suggestions are made as to the methods by which the statistics could be improved, and it is maintained that the only really satisfactory course would be to require the master of each fishing vessel to supply the Board of Trade with correct returns of the fish caught, and of the locality of their capture. In the case of the larger vessels, at any rate, such records already exist, and are supplied by the master to his owners. All that is required is that copies of these records should be furnished to the proper officers, so that the information may be utilised for the general benefit of the public and of the fishing industry. The report will be published, in full, in the forthcoming number of the *Journal* of the Association.

As previously announced, the autumn meeting of the Iron and Steel Institute will be held at Bilbao on September 1-4. The Local Reception Committee, which comprises all the various local authorities, corporations, ironmasters and miners, with Don Julio de Lazurtegui as honorary secretary, has now drawn up an outline programme of the meeting. The Orient Company's s.s. *Ormuz*, which has been detailed to convey the members to Spain, and to serve as a "floating hotel," will leave Tilbury for Portugalete at noon on Saturday, August 29. On the arrival of the *Ormuz* at Portugalete, the Reception Committee will go out to meet the steamer, and will welcome the visitors. Immediately after this visit the members will visit the new harbour and breakwater now in course of construction, and continue up the river Nervion to Bilbao, inspecting on their way the electric installation of MM. Coiseau Couvreux et Félix Allard, for making the mammoth concrete blocks used in the construction of the breakwater. On Tuesday, September 1, the members will formally visit Bilbao, where they will be welcomed by the Alcalde in the *Salon de Actos* of the Provincial College. The general meeting for the reading and discussion of papers will then be held. In the afternoon the members will visit the steel works of the Sociedad de Altos Hornos; and in the evening, there will be a reception by the Alcalde in the new Municipal Buildings. On Wednesday, September 2, after the general meeting and luncheon, the members will visit the steel works and coke ovens of the Sociedad La Vizcaya, and afterwards the tin-plate works of the Sociedad La Yberia. In the evening, there will be a grand tennis match (the basque ball game of *Pelota*) in the Euskalduna Tennis Court, and also a *fête champêtre* and concert, at which the Bilbao Orpheon of 100 members have consented to sing, in the Campos Eliseos. There will be no general meeting on Thursday, September 3, the whole of the morning being devoted to visiting the mines. The *Ormuz* will leave Portugalete on the following day for Santander, where the mines will be visited. Short stays will be made at San Sebastian and St. Jean de Lux on the way back to London, which will be reached on Saturday, September 12.

THE sixty-fourth annual meeting of the British Medical Association will be held at Carlisle, on July 28-31. The President-elect is Dr. Henry Barnes. An address in medicine will be delivered by Sir Dyce Duckworth, and one in surgery by Dr. R. Maclaren. The scientific business of the meeting will be conducted in nine Sections. The President of Section A (Medicine) is Dr. George F. Duffey; and among the subjects down for discussion are: the treatment of cardiac failure, with special reference to the methods of passive exercise, active exercise and baths; anæmia, its varieties, causation, associated pathology, and treatment; tuberculosis, its prevention and cure. In Section B (Surgery), presided over by Dr. A. Ogston, Dr. Macintyre will demonstrate the use of Röntgen rays in surgery, with special reference to the cavities of the body, instantaneous photographs, and fluorescent screens. Section C is devoted to obstetrics and gynæcology; the President is Dr. J. H. Croom. Sir Joseph Ewart, President of Section D (Public Medicine), will open the Section with an address. Among the subjects to be brought forward are: Medical research in relation to hygiene, vaccination and revaccination with animal vaccine in Germany, and diphtheria in town and country. Section E (Psychology) will be opened by the President, Dr. J. A. Campbell, with an address. Most of the papers down for reading and discussion in this Section belong to pathological psychology. An introductory address will be delivered to Section F (Pathology and Bacteriology) by the President, Dr.

Sheridan Delépine; and there will be a discussion on the relation of the morbid conditions dependent on (or associated with) the presence of streptococci. Dr. David Little will preside over Section G (Ophthalmology), Dr. J. Finlayson over Section H (Diseases of Children), and Dr. T. F. I'Anson over Section I (Medical Ethics). A number of garden parties and other social functions have been arranged, and these will help to lighten the large amount of work which the various Sections will have to do.

IT was shown by M. H. Moissan, about three years ago, that when iron was saturated at 3000° C. with carbon, and then cooled under a high pressure, a portion of the carbon separated out in the form of diamond. It occurred to M. Rossel (*Comptes rendus*, July 13), that the conditions under which very hard steels are now made, should also result in the formation of diamonds; and an examination of a large number of samples of such steel has shown that this is really the case. The diamonds are obtained by dissolving the metal in acid, and then subjecting the residue to the action of concentrated nitric acid, fused potassium chlorate, hydrofluoric and sulphuric acids successively. The crystals are very minute (about 15 $\mu\mu$), the largest attaining only 0·5 mm. in diameter, but they present all the chemical and physical properties of true diamonds.

THE detection and estimation of small amounts of marsh gas in air is a problem of considerable practical importance in the ventilation of mines, and numerous instruments having this object have been designed. In the May number of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, Mr. E. Hardy describes a new apparatus for this purpose which presents many novel features. The principle utilised is the variation of the velocity of sound in a gas with its density. The air under examination is forced through a small organ pipe, and the note thus produced compared with that given out by a second pipe fed under parallel conditions with pure air, the number of beats per second produced giving a measure of the methane present, the apparatus being so arranged that the moisture, carbonic acid, and possible variations of temperature exert no influence on the result. Three types of instrument are constructed, portable, fixed, and self-recording. In the second type a telephone from any convenient place is put in connection with two microphones placed on the organ pipes, so that by simply counting the number of beats, the manager can instantly recognise from his office the presence of fire-damp in the part of the mine from which the air is being drawn, 1 per cent. of methane giving about three beats per second. The only drawback to this ingenious apparatus is that it is rather complicated in detail, and therefore costly, especially in the self-recording type; but the advantages of extreme simplicity in actual use, combined with the convenience attaching to the telephone, will doubtless outweigh this in practice.

IN a paper on gall-making coccids, contributed by Mr. C. Fuller to the *Agricultural Gazette* of New South Wales (vii. 4), some details are given concerning the genus Brachyscelis, the members of which live exclusively upon species of Eucalyptus, causing the growth of woody galls, in the heart of which they dwell. These coccids are popularly known in Australia as "gall-makers," but the gall-growth differs from the "meal" of the mealy-bug and the "scale" of the bark-louse—which are other Australian species of Coccidæ—in that it is brought into existence at the actual and direct expense of the tissue of the plants, whilst the meal and the scales are products secreted or excreted from the bodies of the insects themselves. The larvæ of all Brachysceles are so similar in appearance as to afford no sufficient characteristics for the determination of species. The male galls take the form of short cylindrical tubes, not exceeding six lines in length, and generally growing upon the leaves. The female galls exhibit a great variety of forms, which supply the easiest means of distinguishing the different species, and which vary in length from half an inch to six or seven inches. Some resemble cones, others nuts and fruits, whilst the latera growths, due to *B. duplex*, are not unlike leaves. Occasionally supported on stalks, they are more often sessile upon the branches, twigs, or leaves from which they spring. These abnormal members of an aberrant group like the Coccidæ should repay further study.

Do varieties of peas run out? This problem is dealt with in *Bulletin* No. 131 of the Michigan Agricultural Experiment Station, and the answer is that varieties at least lose their original characteristics. Such "running out," however, does not necessarily imply deterioration, as sometimes it is merely a changing of characters. Accurate descriptions accompanied by drawings are kept of varieties of peas grown at the station. These serve to show that varieties change from year to year—even the old standard sorts, the characters of which are supposed to be firmly fixed. The foliage and habit of the plants are found to be less variable than the peas themselves, which are generally the object of selection. The variety Stratagem was grown from seed obtained from three different dealers. In all, the characteristic dark green foliage, stalky, angular veins, and exceedingly short nodes of the variety named were apparent. But the pods, though irregular and varying in each sample, yet, taken as a whole, were distinctly different. In two of the samples the pods were fairly uniform, but in the third they were so irregular—probably reversions to one of the parents—that the peas were almost worthless. It is a matter of common observation that seed peas of the same variety, especially the wrinkled sorts, differ in colour as supplied by different seedsmen. In several cases peas grown on the station grounds have changed the colour of their seed within the last four years.

A BRIEF statement of the facts as to the anti-cholera serum experiments carried out by Prof. Kitasato, of Tōkyō, is made by Dr. A. Nakagawa in the current number of the *British Medical Journal*. Preliminary experiments in the laboratory for ascertaining the curative action of the serum were carried on in this wise: A number of guinea-pigs were inoculated with several times the fatal dose of the virus, so that the untreated animals died within twenty hours after such inoculation. At the expiration of each successive hour injections were made in some of the animals, and it was shown that those treated not later than seven hours after the inoculation of the virus were cured, while those in which the injections were made after the lapse of seven hours could not be saved by the serum. In other words, if injected during the first third of the entire course of the disease (thus experimentally produced) the serum can be considered curative. Cases of cholera were afterwards treated with anti-cholera serum at the Hiroo Hospital, Tōkyō. Of 270 cases admitted, 138 died, which gives a rate of mortality of 51·1 per cent. Anti-cholera serum was employed in 193 cases only, owing to the fact that the supply of serum was inadequate to allow it to be used in all cases. The rate of mortality among Japanese in nearly all the previous epidemics, as well as that of the last epidemic, has always been about 70 per cent. Without claiming to draw, from a number relatively so small, the final conclusion that the serum treatment was attended with the reduction of 20 per cent. in the mortality statistics, it is evident at least that the result of the new therapy was not an unfavourable one. Moreover, Dr. Nakagawa thinks there is reason to believe that, with a sufficient supply of very efficient serum, the rate of mortality can still be lowered.

STUDENTS of Japanese culture will be interested in a paper on "Anatomy and Æsthetics among the Japanese," in *Globus*

(Band lxx. p. 21), by Max Buchner, and in the folk-lore contained in P. Ehmann's paper on "Popular Notions in Japan," in the current volume of *Œsterreich. Monatsschr. für den Orient*, p. 58.

DR. F. SOSSET has published in the *Revue de l'Université de Bruxelles* (vol. i. p. 481) a painstaking account of weaving in Ancient Greece, and has employed various representations from Greek vases and other sources to illustrate the accounts given by the classical writers. Those who are interested in the development of the industrial arts should consult his memoir.

THE contemporaneity of Man with the Gigantic Fossil Sloth Megalonyx appears to be now established, Mr. H. C. Mercer having recently obtained distinct evidence on this point in the Big Bone Cave, Van Buren County, Tennessee. The full report, which will be published by the Archæological Department of the University of Pennsylvania, will be awaited with interest, as it should provide data towards the solution of the problem of the length of time man has existed in the New World.

THE British Museum possesses several very beautiful and valuable examples of Ancient Mexican mosaic work. These, together with examples in other European museums, have been figured and described by Mr. A. Oppel in *Globus* (Band lxx. p. 4). The most important material of these mosaics is turquoise; in none is it wanting, and on one shield in Vienna it is the only stone employed, tesseræ of shell (white, light red, and purple-red), nacre, malachite, gold, obsidian, and other materials are also employed. The masks, head-dresses, shields, and other objects which were decorated in this sumptuous manner, were evidently employed in the ancient religious ceremonies.

UNDER the title of "Common Sense in Chess," an abstract of twelve lectures delivered by Mr. Lasker in London last year, has been published by Messrs. Bellairs and Co. As an exposition of the methods of this brilliant player, this pamphlet will be read with much interest, more especially since, instead of the exhaustive variations of the openings customary in works of this class, an attempt is made to base the conduct of the game upon a few simple general principles. These principles are advanced in the opening chapter as empirical rules, to which the games worked out in the subsequent chapters supply the proof.

WE are glad to be able to report a considerable step in advance made by the Observatory at Athens by the publication, from the 4th ult., of a daily weather report containing twenty-five stations in Greece, and about double that number of exterior stations. The report is accompanied by two charts, one showing the isobars and general meteorological conditions at 8 a.m. over a large part of Europe, and one showing wind and temperature over Greece and adjacent islands. Observations have been made regularly at the Athens Observatory since 1858, some of which have been published and discussed: but we are not aware that the issue of synchronous charts, in the form adopted by other countries, has been before attempted.

THE additions to the Zoological Society's Gardens during the past week include a Squirrel Monkey (*Chrysothrix sciurea*) from Guiana, presented by Mrs. Turner-Turner; a Huanaco (*Lama huanacos*, ♂) from Bolivia, presented by Mr. J. F. Schwann; a Passerine Owl (*Glaucidium passerinum*), European, presented by Miss Bloxam; four Rough-keeled Snakes (*Dasypeltis scabra*), a Lineated Boodon (*Boodon lineatus*), a Rhomb-marked Snake (*Psammophylax rhombeatus*), a Delaland's Lizard (*Nucras delalandii*) from South Africa, presented by Mr. Frederick A. Story; an Agile Wallaby (*Halmaturus agilis*, ♀) from Australia, an Indian Python (*Python molurus*) from India, seven Peruvian Snakes (*Tachymenis peruviana*), nine —— Lizards (*Liolæmus* sp. inc.), five Gay's Frogs (*Calyptocephalus gayi*), six Bibron's Frogs (*Paludicola bibroni*) from Chili, deposited; a Brazza's Monkey (*Cercopithecus brazzæ*, ♀) from French Congoland, a Tayra (*Galictis barbara*) from South America, a Patagonian Conure (*Conurus patagonus*) from La Plata, purchased.

IN our report of the celebration of the Kelvin jubilee, on p. 177 of our issue of June 25, Prof. Cleveland Abbe was inadvertently credited with being the "head of the Meteorological Office, Washington." To prevent misapprehension, it may be desirable to state that the responsible position of Chief of the U.S. Weather Bureau is actually filled by Prof. Willis L. Moore.

OUR ASTRONOMICAL COLUMN.

DOUBLE STAR ORBITS.—In the *Astronomical Journal*, No. 378, Dr. See gives the complete list of the various double star orbits that he has computed and published in various journals. This is a useful compilation, and testifies to a considerable amount of industry, and exhibits his great interest in the subject. The "probable uncertainty" which he has attached to some of the elements is, however, very different from "the probable error," which is an arithmetical result, and has a definite meaning. The "limits of uncertainty" attached to the period and excentricity, give Dr. See's estimate of the degree of success with which he has handled incorrect and inadequate measures. Almost simultaneously with the appearance of Dr. See's paper comes, in *Ast. Nach.*, No. 3364, Dr. Doberck's results of his investigation of the orbit of γ Virginis, and it is scarcely necessary to remark, that he has had under review precisely the same observations that Dr. See has used. If Dr. Doberck is able to add one or two more recent observations, they have been made at a time when the companion is near aphelion, and have little influence on the orbit. Nevertheless, the period and excentricity differ more from the values that Dr. See has obtained than his assigned values of uncertainty. If, then, the treatment of the same observations, by experts in this class of computation, lead to sensibly different orbits, it is to be feared that new material, arising from the continued observation of stars that have been much less frequently measured than γ Virginis, will lead to still wider discrepancies.

ROTATION PERIOD OF JUPITER.—The movements of the various spots, &c., on the surface of Jupiter have been employed since the time of Schrœter (1787) for observing the period of rotation of the planet. During the last opposition two very marked spots have been specially persistent, and by means of one of them, the "Garnet" spot, Prof. A. A. Rambaut has made a new determination of the period (*Scien. Proc. Roy. Dublin Soc.*, vol. viii. p. 389). All the values hitherto found have demonstrated that the various parts of the surface rotate at different speeds, so this new value simply refers to the zone in which the spot is situated. This is the one having a zenographical latitude of $+13°$, the previously accepted period of which was 9h. 55m. 33·9s. The time was measured by taking the intervals between the transits of the spot over the fixed wire of the micrometer on the "South" equatorial. The time of central transit was taken as the mean of the preceding contact, bisection, and following contact of the spot. Corrections were applied for three sources of error which affect the result, viz.: (1) *Parallax*, (2) *velocity of light*, (3) *phase*. The final value of the rotation of this spot is 9h. 55m. $33·36 \pm 0·53$s., which agrees within one-fifth of a second with Schrœter's value.

TELLURIC LINES.—Prof. Ricco has been investigating the relative behaviour of the chief atmospheric lines of the solar spectrum under various observing conditions (*Mem. del Soc. Spettroscopisti Italiani*, vol. xxv. pp. 127–134, 1896). The lines particularly under discussion were 6868 (β), 6517, 6278 (α), 5943 (rainband), and 5800 (δ). Observing the spectrum with a direct vision spectroscope, the relative intensities of these lines were measured in three districts, Etna, Nicolosi, and Catania, with the sun at varying altitudes at each station. From the measured altitudes, the thickness of the absorbing stratum of air traversed was calculated for each observation. The tension of the aqueous vapour in the air was also recorded at the time each line was measured. On plotting the results graphically, and summing up the measures at each station, the general con-

clusion is that the intensities of all the lines were nearly proportional to the mass of air traversed. The lines 6868 (β), 6517, 6278 (α), and 5800 (δ) were practically of the same intensity, for equal masses of air, at all the three observing stations, showing that the presence of water-vapour had little or no influence on them, and indicating that their origin was most probably atmospheric oxygen. The *rain-band* line (5943), however, has, for equal masses of air, a much less (about one-third) intensity at Etna than at the other two stations. The mean vapour tensions at the three places, Etna, Nicolosi, and Catania, were as 3 : 7 : 10, so that this line 5943 is evidently due to aqueous vapour. The fact that when the observations are plotted the curves pass through or near the origin, indicates that the atmospheric oxygen and water-vapour are the sole causes of these telluric lines.

EXPLANATION OF SOLAR PHENOMENA.—In the June number of the *Astro Physical Journal*, J. Fényi discusses several new explanations of the various features of the solar surface, emphasising several physical facts, hitherto neglected, the consideration of which simplify the conception of the causes of the solar phenomena. He assumes that the prominences are masses of real matter in violent motion, and also that they are ejected into *free space*. The crucial point of his argument is that when a mass of hydrogen, say, is projected from the photosphere, and has passed through the chromosphere into free space, it is not diffused immediately, but takes a certain time, termed the *expansion interval*, which varies *directly* as the diameter of the mass, and is *inversely* proportional to the square root of the absolute temperature. By following out in detail the phenomena of eruptive prominences, he explains them all on this view, especially their unusual brightness and rapid dissolution. The *white* prominences he accounts for as being the expanded gaseous portions of former ordinary prominences, rendered visible by reflected sunlight. The *corona* he regards as being due to more distant masses of these gaseous materials, primarily ejected as prominences, the enormous length of some coronal streamers being no difficulty if they are admitted to be projected in free space. *Faculæ* will then be produced by these gaseous matters falling down on the photosphere again, their superior brightness being due to the heat generated during their fall, together with the actual radiation received from the sun itself. Their prevalence in sun-spot zones is explained if they are the consequence of eruptive prominences, which themselves favour these zones. This dispenses with the view that faculæ are projected prominences, and regards them as the *result* of prominence action. The much-disputed question of the reason of distorted spectral lines in prominences is greatly simplified by this explanation. If a mass of ascending gas as a prominence encounters a descending mass from a previous eruption, the resultant motion will in general be tangential to the solar surface, and will be capable of producing the enormous velocities in the line of sight which have been measured in prominence spectra, and which could not be explained as being the result of mere explosions from the photosphere.

NEW FORM OF APPARATUS FOR THE PRODUCTION OF RÖNTGEN RAYS.

SOME time in the month of March this year, after working with various forms of tubes, it occurred to the writer to abolish the glass vessel by converting the ordinary concave kathode into a nearly complete sphere, with the platinum anode at its centre. A simple experiment with a Jackson bulb proved that the rays from the anode could pass through the material of the kathode as they would through a similar piece of unelectrified aluminium placed outside the bulb. Hence it became fairly evident at the outset that the proposed plan would work to some extent.

Under the guidance of Prof. Lodge, and in his research laboratory, experiments were commenced. The first arrangement was a simple one. The sphere was made in two halves, one half of copper and the other of aluminium. The two halves were joined together with marine glue only. The anode was held in position by ebonite fixed in the copper hemisphere. A section of this simple arrangement is shown in Fig. 1. The section is drawn to scale, the diameter of the sphere being 2 inches. This early apparatus showed signs of success, and it was decided to invest in a larger sphere—one of $3\frac{1}{2}$ inches in diameter. The joints were now made much more carefully, and the apparatus so designed that it could be fitted together or taken to pieces in half an hour's time. The hemispheres of copper and aluminium were soldered together, but the joints (A and B, Fig. 1) were made by compressing indiarubber washers by means of suitably made screws. With this convenient apparatus the behaviour of various sizes and shapes of anodes was observed. In all the experiments a small thick plate of platinum, having a plane surface of about $\frac{1}{4}$ square inch, was reserved for that portion of the anode which received the kathode rays; the remainder of the anode was sometimes of aluminium and sometimes of copper. The various forms tried are shown in Figs. 2 to 8.

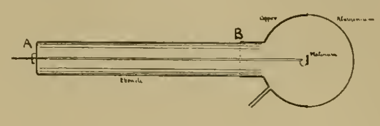


Fig 1

In Fig. 2 we have the simplest possible anode—the platinum plate alone. It is the same arrangement as that of Fig. 1, the only difference being that of dimensions. This form possessed an enormous resistance, so that only with low vacua could a current be made to pass through. For this reason the behaviour of this form was unsteady and its periods of activity very short. With higher vacua and greater potentials, no doubt this form would be more successful. Another form tried was that shown in Fig. 3. The anode here was very considerably enlarged by placing a circular plate of metal just behind the platinum, at a place where no kathode rays could fall on it. By this means the area of the anode surface was increased sixteen-fold approximately. The resistance was thereby much reduced, and it became possible to work at higher vacua. This form gave a more powerful and a considerably more uniform radiation than that of its predecessor.

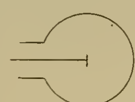


Fig 2

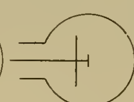


Fig 3

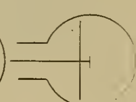


Fig 4

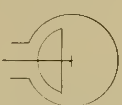


Fig 5

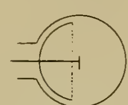


Fig 6

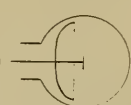


Fig 7

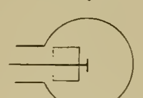


Fig 8

The next step was to increase still further the area of the anode (see Fig. 4). The anode now nearly filled the sphere. The result, however, was not so good, tending to show that the best size of anode is something less than Fig. 4, and greater than Fig. 2; but Prof. Lodge thinks that this is a question of the particular vacuum employed. Another differently-shaped anode was next tried. This was formed of a metallic hemisphere with a flat plate in front of it (see Fig. 5). The idea was to get all, or nearly all, of the electric discharge, and so possibly most of the kathode radiation also, to take place between the outer aluminium hemisphere and the anode. The idea probably is a crooked one; anyhow, this form proved less successful than others. The plate was next removed, and the hemisphere was replaced by a larger one, as in Fig. 6. For some unknown reason this form gave no radiation whatever, although the

vacuum was fairly high. The resistance, however, was low. The experiment was not really a successful one, for there arose some trouble from either small leakages or vapour pressures. The next form was Fig. 7. This gave really bright flashes on a sensitive screen, and the resistance was low. Still another form is that of Fig. 8. The anode now is a hollow cylinder with one end open. The total area of this anode is considerably greater than that of Fig. 3, but the latter gave much the more powerful radiation. It appears, therefore, that both the size and the shape of the anode have an important influence on the radiating power of the apparatus.

The form which gave the most powerful radiation was that of Fig. 3. This sent a powerful radiation through 3 feet of solid timber. The rays on emerging were received on a fluorescent screen made of about fifteen shillings' worth of potassium-platino-cyanide, and the area of which was 36 square inches. This screen was considerably affected by the rays after having traversed the 3 feet of timber, and gave sufficient light to see very small objects in. But the hand, when placed between the screen and the timber, cast no shadow whatever.

The next observation on the power of the radiation was to take the screen to a distance of 30 feet from the source. At this distance the bones of the hand could be seen, but not the flesh. Even the bones cast no deep and sharp shadows at this distance, not owing to lack of fluorescence—for the screen was really bright—but owing probably to the turbidity of the intervening 30 feet of air.

The source was afterwards placed in position at one end of the laboratory, and the screen taken to the opposite end, or rather to the end of the corridor leading to the laboratory—a distance of 62 feet from the source. Even here the screen fluoresced with some energy, but the hand was observed to cast no perceptible shadow. When this apparatus was working, there was no place within the large room where the screen did not fluoresce, the rays passing through masses of timber and tables with surprising penetration.

This experimental tube, however, with its rubber joints and ebonite insulation, is not a lasting concern. Although a good vacuum can be maintained for hours together when not in work, it will not last more than half an hour or so when in continuous use, after which more pumping is necessary. The current evidently produces some change in the rubber and ebonite, disengaging a gas which slowly destroys the vacuum.

In the final instrument the joints are of mercury, and the insulation of porcelain. The joints are first ground and polished, and then flooded with mercury. Except the porcelain, the entire apparatus can be made in the lathe, which is a great consideration. A longitudinal section of the instrument is given in Fig. 9. At the end of the porcelain is an arrangement for focusing, which can be manipulated while the instrument is working, so that a point source can be obtained definitely and easily by trial. This figure, which is reproduced from an early picture, has a spherical anode. This should be replaced by a circular plate resembling the anode of Fig. 3.

This last form of instrument, though designed in the middle of May, has not yet been built, owing to the delay in manufacturing the various parts. The parts are easily enough made, but manufacturers seldom care to attend to single articles except at their own convenience.

In conclusion it may be stated, though it is unnecessary to do so, that the instrument just described owes its existence to the teaching of Prof. Lodge. BENJAMIN DAVIES.

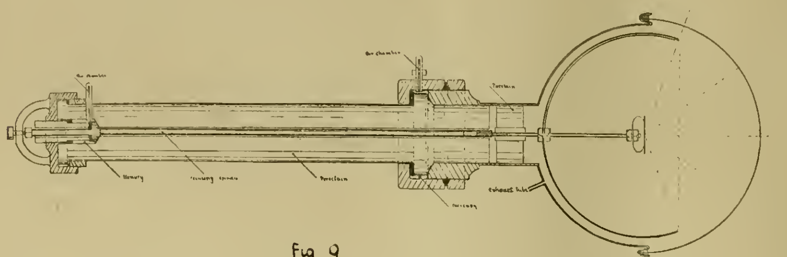


Fig 9

THE ROBOROVSKY EXPEDITION.

ROBOROVSKY and Kozloff, the two explorers who accompanied Prjevalsky in his last journeys, and for two years continued his work of exploration of Central Asia, are now back at St. Petersburg; and they have returned literally loaded with zoological, botanical, and geological collections, together with the results of meteorological observations and extensive surveys, as well as of numerous astronomical determinations. The chief interest of the collections will certainly be centred round the specimens of the wild horse (*Equus Przewalskii*) and wild camel which they have secured, as well as in the great numbers of new species of plants and insects which have been systematically collected by M. Kurilovitch, who stayed at well-chosen stations, while Roborovsky and Kozloff, mostly accompanied by one man only, made the most adventurous "excursions"—that is, journeys three and four hundred miles long—into the unknown highlands of the Nan-Shan. Great privations were endured by the two explorers during these journeys, which were made without guides, during the winter, when the thermometer stood at $-25°$ to $-35°$ C., and fearful snow-storms blew away the tent, while the sand borne by the wind sharply stung the travellers' frozen faces. These privations, of which the Russian travellers speak so light-heartedly, seem, however, to have ruined the health of the chief of the expedition, Roborovsky. And when the expedition made its last journey into the highlands which separate the Nan-Shan highlands from the valley of the Yellow River, Roborovsky, who had already endured pleurisy and erysipelas, was laid down with a stroke of paralysis, which deprived him of the use of all the right part of his body; while the Tangut robbers, who people these mountains, gathered in bands round the small encampment. The expedition was already at the western foot of the high snow-clad chain of peaks of the Alma-machin, which rise on the left bank of the famous bending of the Yellow River; a few days' journey only separated them from the yellow waters of the Hoang-ho; but in such conditions they were compelled to return—the Tanguts immediately taking advantage of the retreat to attack the caravan. They were only repulsed, Roborovsky writes, after "a great loss in men and horses."

Notwithstanding this failure, even the purely geographical results of the expedition, to say nothing of its scientific collections, are very important. From Lake Issyk-Kul the small party proceeded eastwards, exploring the highlands and the plateau of Yulduz, to Karashar, near Lake Denghiz, or Bagrach-Kul, and thence to Turfan and the oasis of Hami. Having now to cross the great desert of the Hashun Gobi, before reaching the Nan-Shans, Roborovsky and Kozloff took

two different routes: the eastern route, Hami to Sa-chou, and the western route, from Kurla to Lob-nor, and thence eastwards to Sa-chou, along the northern foot of the great border ridge, the Altyn-tagh. Two excursions made, for 150 miles, into the interior of the desert gave an insight into its physical features, flora and fauna. Moreover, before crossing the Gobi, the expedition explored in detail the remarkable Lukchun depression (in the south-east of Turfan), which was discovered by the brothers Grum-Grzimailo, and proved to be some 150 feet below the level of the ocean, although it is surrounded on all sides by high plateaus. Roborovsky established there a meteorological station, at which the barometer was observed for two consecutive years, and, accordingly, it may now be taken as certain that the surface of this depression is really from 150 to 300 feet below the sea-level.

Spending nearly one year in the Nan-shan highlands, the expedition has covered them with a whole network of surveys; so that when these surveys, as well as Obrucheff's researches are taken into account (as they are in a preliminary map appended to the *Izvestia* of the Russian Geographical Society), we see this region, almost entirely unknown three years ago, better explored now than many parts of Siberia. Where one ridge only was formerly drawn, we find on the new map a series of parallel ridges all running W.N.W. to E.S.E., intersected by high valleys, and attaining by their snow-clad peaks the heights of from 14,000 to 16,000 feet in the chains of Humboldt, Ritter, Da-sue-shan, and Alexander III.'s. The beginnings also have been made of a careful exploration of the Altyn-tagh, which was formerly known through Prjevalsky's and Littledale's journeys along its outer border.

It is pleasant to add that Roborovsky's health has much improved during the return journey, and that, on arriving in Russian Turkestan after a two years' absence, he could report "all well." The account of this journey will add several more important volumes to the scientific literature of Central Asia.

EVAPORATION.[1]

THE quantities of water added to the atmosphere daily by evaporation from the oceans and the continents constitute a fundamental consideration in meteorology; the quantities evaporated from cultivated fields, forests, and other forms of vegetation are equally important in agriculture, but as yet we have confessedly attained to only a very imperfect knowledge of this subject. Meteorologists have generally observed the amount evaporated from a small surface of water exposed either in the open air and sunshine, or else within such a shelter as is used for the open-air thermometer; lately a disc of moist paper has been substituted for the surface of water, as in the Piche evaporometer. Agriculturists, on the other hand, have made use of the lysimeter, which consists of a deep metallic box buried in the earth and having its open upper side flush with the surface of the ground. This box is filled with soil in which plants may or may not be growing, according to the object of the investigator. Record is kept of the amount of water or rain that is added to the lysimeter box from day to day, and also of the amount of water that drains from the bottom of the box. The difference between the two is adopted as the natural evaporation from the soil. The soil in the box may be kept very wet, to imitate a morass, or very dry to imitate a desert; the fineness of the soil may vary from coarse gravel to the finest silt.

If we desire the actual amount evaporated into the atmosphere, we must do more than record the results of the above forms of apparatus. The evaporating surface of water in the shaded thermometer shelter will indeed give up its moisture in proportion to the temperature of the water and to the velocity and dryness of the wind at its surface; but these three important factors have values so different out of doors from those within the shelter, that such records can, at the best, only give us a crude idea of the actual evaporation from surfaces in the open air. A great evaporation within the shelter, caused by a strong, hot, dry wind, may be accompanied by but little evaporation from the surrounding country if the latter be a desert of rock and gravel.

On the other hand, by means of the lysimeter, one may indeed determine directly the evaporation from soil of any character exposed to the natural outdoor conditions; but there then remains the difficult task of determining how much soil of each respective kind really occurs in the surrounding territory. In order, therefore, to determine the actual evaporation from land surfaces, one must observe a large number of lysimeters, and make an extensive minute survey of the country. The calculations incident to this latter method are very laborious.

The ordinary psychrometric observations give the dew-point or quantity of moisture in a small unit volume of air at any moment. If in the course of the day this quantity increases, we are not thereby warranted in concluding that the increase is due to a local evaporation; it may have been brought from a distance by the wind, or it may even have come down from the clouds as rain. If observations of dew-point are carefully made on all sides of a large field, over which a gentle wind is blowing, and if it should appear that there is a little more moisture in the air on the leeward side than on the windward side, one might conclude, provisionally, that this increase represented the quantity of moisture thrown by evaporation into the air as it gently moved over the surface of the field. But even this conclusion must be modified indefinitely by the consideration that in blowing across the field the wind does not move horizontally, but in a series of rolls and whirls by which the lower air in which we are observing becomes mixed with upper air, about whose moisture we know little or nothing.

In the midst of all these uncertainties it seems almost hopeless to attempt anything like an accurate determination of the moisture actually added to the atmosphere by evaporation from any extensive region of land or water; the question is far more complex than the determination of the evaporation from a reservoir of water, which latter problem is often attacked by the hydraulic engineers. Including the earth and its atmosphere in one comprehensive view, we may certainly say that the total annual evaporation from snow and ice, fresh water and salt water, must average the same as the total annual precipitation. We may even make an annual average for each continent, and say that the evaporation from the land plus the water that flows away in the rivers must equal the rainfall, and as the river discharge is frequently well known, we may, by subtraction, infer the evaporation. For the oceanic surface, on the other hand, the evaporation must equal the rainfall plus the river discharge from the continents.

The latest contribution to our knowledge of evaporation from land surfaces is published by Prof. E. Wollny, of Munich, at page 486, vol. xviii., of his "Forschungen." As the result of three years' continuous observations of five lysimeters and a neighbouring evaporometer, he concludes:

(1) That the quantity of moisture evaporated from the soil into the atmosphere is considerably smaller than that evaporated from a free surface of water.

(2) That the evaporation is smallest from naked sand, and largest from naked clay, whereas naked turf and humus or vegetable mould have a medium value.

(3) That the evaporation is increased to a considerable extent by covering the ground with living plants.

As the result of a minute analysis of the complex relations between the evaporation and the meteorological elements, on the one hand, and the physical features of the soil, on the other, Dr. Wollny further concludes as follows:

(4) Evaporation is a process that depends both upon the meteorological conditions and on the quantity of moisture contained by the substratum of soil.

(5) Among the external circumstances temperature is of the greatest importance, inasmuch as, in general, evaporation increases and diminishes with it; but this effect is modified according as the remaining factors come into play, and in proportion to the quantity of water supplied by the substratum.

(6) The influence of higher temperature is diminished, more or less, by higher relative humidity, greater cloudiness, feebler motion of the wind, and a diminished quantity of moisture within the soil, whereas its influence increases under opposite conditions. On the other hand, low temperatures can bring about greater effects than high temperatures if the air is dry, or the cloudiness small, or the wind very strong, or if a greater quantity of water is present within the evaporating substance.

(7) For the evaporation of a free surface of water, or for earth that is completely saturated with water, the important elements are—first the temperature, next the relative humidity

[1] Prof. Cleveland Abbe, in the U.S. *Monthly Weather Review*.

of the air, and then the cloudiness, direction and velocity of the wind; whereas, for the ordinary moist earth, no matter whether the surface is naked or covered with living plants, it is the quantity of rain upon which the soil depends for its moisture that is the important additional consideration. The effects of the external elements on evaporation become less important, as explained in paragraph 5, in proportion as the precipitation is less and as the soil is more completely dried out by the previous favourable weather, and *vice versa*. For these reasons the rate of evaporation from a free surface of water not infrequently differs largely from that from the respective kinds of soil.

(8) Free surfaces of water, and soils that are continuously saturated, evaporate into the atmosphere on the average more water under otherwise similar circumstances than soils, whether naked or covered with plants, and whether watered artificially or naturally. Only at special times, viz. when the influence of the factors that favour evaporation is most intense, when the plants are in the most active period of growth, and when the soil contains a large percentage of water, can the land that is covered with plants show a larger evaporating power than the free-water surface.

(9) When a soil that is not irrigated is covered with plants, it evaporates a far greater quantity of moisture than when the surface is bare. In the former case the evaporation can not exceed the quantity received by the soil from the atmosphere before or during the period of growth. Swampy lands and those that are well irrigated, as also free surfaces of water, can, under circumstances favourable to evaporation, sometimes give to the atmosphere a greater quantity of water than corresponds to the precipitation that occurs during the same time.

(10) The evaporating power of the soil is, in itself, dependent upon its own physical properties; the less its permeability for water, or the larger its capacity for water and the easier it is able to restore by capillarity the moisture that has been lost, by so much the more intensive is the evaporation. For this reason the quantity evaporated increases with the percentage of clay and humus in the soil, whereas it diminishes in proportion as the soil is richer in sandy and coarse-grained materials.

(11) Soil that is covered with plants loses by evaporation so much more water in proportion as the plants are better developed, or stand thicker together, or have a longer period of vegetation, and *vice versa*.

In conclusion, Wollny repeats that the use of apparatus giving the total evaporation from free-water surfaces does not respond to the needs of the agriculturist [and we may add of the meteorologist], but that instruments must be used for measuring the evaporation from masses of earth that are wet with rainfall only, and free from stagnant wet soils. Lysimeters are recommended having a section of one-tenth of a square metre and a depth of soil one-half of a meter, and set out in the open air, sunk flush with the surface of the ground, and arranged so as to be easily weighed at any moment, and so that the drainage water can easily be measured.

The foregoing results of Wollny's laborious observations confirm us in the general conclusion that the quantity of water actually evaporated from a large surface of land, such as a definite watershed maintaining a single river, can only be determined by the following considerations. The quantity of water contained in the soil at the end of any given period in excess of what it contained at the beginning, plus the water that is carried off by drainage and river flow, plus whatever is evaporated into the atmosphere either directly or through the crops and forests, must equal the rain and irrigation water added to the soil during that time. As the soil content of water, the riverflow and drainage, and the rainfall can be severally determined by direct observation far better than the evaporation, the latter is to be determined by taking the difference between the rainfall and all other sources of loss or consumption.

LONDON UNIVERSITY COMMISSION BILL.

REFERENCE was made in our issue of July 9, to the Bill introduced by the Duke of Devonshire in the House of Lords, for the purpose of appointing a statutory Commission to make further provision with respect to the University of London. The Bill reads as follows:—

Whereas the Commissioners appointed to consider the draft charter for the proposed Gresham University in London, have by their report made recommendations with respect to the reconstitution of the University of London, and to the appointment of a statutory Commission for that purpose:

Be it therefore enacted by the Queen's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same, as follows:—

I. *Appointment of Commissioners.*—(1) There shall be a body of Commissioners styled the University of London Commissioners, and consisting in the first instance of the following persons [names not yet announced].

(2) If and whenever any vacancy occurs among the Commissioners, it shall be lawful for Her Majesty the Queen to appoint a person to fill the vacancy; but the name of every person so appointed shall be laid as soon as may be before both Houses of Parliament.

(3) The Commissioners may, with the consent of the Treasury as to number, appoint or employ such persons as they may think necessary for the execution of their duties under this Act, and may remove any person so appointed or employed.

(4) There shall be paid to any person so appointed or employed such remuneration as the Treasury may assign, and that remuneration and all expenses of the Commissioners incurred with the sanction of the Treasury in the execution of this Act shall be paid out of moneys provided by Parliament.

II. *Duration and proceedings of Commissioners.*—(1) The powers of the Commissioners shall continue until the end of the year one thousand eight hundred and ninety-seven, and no longer; but it shall be lawful for Her Majesty the Queen, from time to time, with the advice of Her Privy Council, on the application of the Commissioners, to continue the powers of the Commissioners for such time as Her Majesty thinks fit, but not beyond the end of the year one thousand eight hundred and ninety-eight.

(2) The Commissioner first named in this Act shall be the Chairman of the Commissioners; and in case of his ceasing from any cause to be a Commissioner, or of his absence from any meeting, the Commissioners present at each meeting shall choose a chairman.

(3) The powers of the Commissioners may be exercised at a meeting at which three or more Commissioners are present.

(4) In case of an equality of votes on a question at a meeting, the chairman of the meeting shall have a second or casting vote in respect of that question.

(5) The Commissioners shall have a common seal which shall be judicially noticed.

(6) Any act of the Commissioners shall not be invalid by reason only of any vacancy in their body; but if at any time, and as long as, the number of persons acting as Commissioners is less than four, the Commissioners shall discontinue the exercise of their powers.

III. *Powers and duties of Commissioners.*—(1) The Commissioners shall make statutes and regulations for the University of London in general accordance with the scheme of the report hereinbefore referred to, but subject to any modifications which may appear to them expedient after considering any representations made to them by the Senate or Convocation of the University of London, or by any other body or persons affected.

(2) In framing such statutes and regulations, the Commissioners shall see that provision is made for securing adequately the interests of collegiate and non-collegiate students respectively.

(3) Statutes and regulations made under this Act shall have effect notwithstanding anything in any Act of Parliament, charter, deed, or other instrument.

IV. *Approval of statutes and regulations.*—(1) When any statute or regulation has been made by the Commissioners, a notice of its having been made, and of the place where copies of it can be obtained, shall be published in the *London Gazette*, and the statute or regulation shall be laid as soon as may be before both Houses of Parliament, and shall not be valid until it has been approved by Her Majesty the Queen in Council.

(2) If either House of Parliament within forty days, exclusive of any period of prorogation, after a statute or regulation has been laid before it, presents an address praying the Queen to withhold her assent from the statute or regulation, or any part thereof, no further proceedings shall be taken on the statute or regulation, or on the part thereof to which the address relates, but this provision shall be without prejudice to the making of a new statute or regulation.

(3) The Senate or Convocation of the University of London, or any other person or body directly affected by any such statute or regulation, may, within thirty days after the notification thereof in the *London Gazette*, petition Her Majesty in Council to withhold her approval of the whole or any part thereof.

(4) Her Majesty in Council may refer any such petition to a committee of the Privy Council, with a direction that the committee hear the petitioner personally or by counsel, and report specially to Her Majesty in Council on the matter of the petition.

(5) Thereupon it shall be lawful for Her Majesty by Order in Council either to declare her approval of the statute or regulation in whole or in part, or to signify her disapproval thereof in whole or in part, but any such disapproval shall be without prejudice to the making of a new statute or regulation.

(6) The costs of any petition under this section may be regulated by the committee to which the petition is referred.

V. *Power to amend statutes and regulations.*—After the expiration of the powers of the Commissioners the Senate of the University shall have power to make statutes and regulations for altering or supplementing any of the statutes or regulations made by the Commissioners. Provided as follows :—

(1) A statute made under this section shall be subject to the provisions of the last foregoing section, with the substitution only of the Senate for the Commissioners ;

(2) A regulation made under this section shall be invalid so far as it is inconsistent with any statute made under this Act and for the time being in force.

VI. *Short title.*—This Act may be cited as the University of London Act, 1896.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A DESPATCH (says the *Board of Trade Journal*) has been received at the Foreign Office from Mr. Martin Gosselin, Her Majesty's Chargé d'Affaires at Berlin, stating that a Government chemical dyeing school has recently been opened at Crefeld, which has cost about £20,000, exclusive of the machinery and fabrics, which have for the most part been presented by private manufacturers. The school contains laboratories for research and educational purposes, as well as a complete collection of dyeing machinery, and an exhibition showing the result of different processes.

THE following are among recent announcements :—Dr. Franz Boas to be lecturer on physical anthropology in Columbia University ; Dr. Arthur Allen to be professor of psychology and pedagogy in the Ohio University ; Dr. Bauer, professor of mineralogy at Marburg, to be Privy Councillor ; Dr. H. Biltz to be extraordinary professor of chemistry at Greifswald ; Dr. Linde, professor of physics in the Munich Technical High School, to be Ph.D. *honoris causa* of Gottingen University.

PLANS have been filed for the buildings of Barnard College in New York City. Three halls have been provided for. The central one is named Milbank Hall, in honour of the donor, Mrs. Anderson, *née* Milbank, and will cost 160,000 dols. Opposite the grounds of Columbia University will be Brinkerhoff Hall, costing 132,000 dols., the gift of Mrs. Brinkerhoff. The third hall for which the plan provides will correspond to Brinkerhoff Hall. Funds are not yet provided for it, nor a name assigned.

SCIENTIFIC SERIALS.

American Journal of Science, July.—Lecture experiment with liquid carbon dioxide, by C. Barus. The passage from the liquid into the gaseous state should be shown in full daylight, the tube containing the liquid being placed vertically in a wooden trough closed by plate-glass at both ends. This insures safety, and gives more light than a water-bath. The image of the tube is thrown upon a screen. Two different focal lines are obtained, one for the gas, the other for the liquid. Contrary to what might be expected, the one does not pass continuously into the other, that for the gas being always virtual, and that for the liquid real.—Percussion figures on cleavage plates of mica, by T. L. Walker. These figures, produced by a blow on the centre of a hexagonal plate with a blunt needle, have been described as being six-rayed stars with the rays at 60° to each other. Accurate measurements show that the angles may vary from 53° to over 63°, according to the kind of mica employed.—The seven-day weather period, by H. Helm Clayton. To extend the investigation of the seven-day weather period beyond the area of the United States, three stations were selected in the Arctic region, five in Europe, two in Asia, two in Oceania near the equator, three in middle South America, one in Mauritius, and one in Australia. The periods investigated were those of 7 days 6·43 hours, 6 days 3·95 hours, and 5 days 10·8 hours. Particular attention was given to a compilation of barometric minima at these stations during the last fifteen years. The results show that, on the average, twice in a period of 7 days 6·43 hours in America, and three times in Europe, waves of barometric minima, or storms, tend to begin near the poles, and sweep across the continents. There is a tendency at every station for the days of maximum frequency to remain on the same days of the period throughout the year.—The hydrology of the Mississippi, by J. L. Greenleaf. This is a valuable and interesting paper dealing with the drainage areas, rates of flow, and rainfall over the tributaries of the great American river. It is illustrated by diagrams representing the various factors in a concise and lucid manner. The largest drainage area is that of the Missouri. Then follows the Ohio, the Arkansas, and the Red River. Of these, the Missouri has the most striking peculiarities. Its drainage area has an average rainfall of 19·6 inches per annum. Although in flood it is a mighty torrent, its average volume is very poor considering its enormous drainage area of 527,700 square miles. Only 12 per cent. of the rainfall finds its way into the river. The rest is absorbed and evaporated by the extensive prairies. In the Ohio area the proportion is 30 per cent., and since the annual rainfall is 43 inches, it is not surprising that its discharge exceeds that of the Missouri. Near the Mexican Gulf we have the Yazoo and St. Francis Rivers, which carry off 70 per cent. of their rainfall, owing to its being quickly absorbed by the sandy soil, or stored in the swamps. There are other admirable diagrams showing the growing volume of water as each tributary enters, and giving the whole life-history of the river system in a very attractive shape.

Wiedemann's Annalen der Physik und Chemie, No. 6.—Electrolysis of water, by A. P. Sokolow. Helmholtz applied his theorem of free energy in thermodynamics to electrolysis, and concluded that the E.M.F. necessary to electrolyse water depends upon the density of the hydrogen and oxygen at the electrodes, and that when the liquid is free from gas the necessary E.M.F. may closely approximate to zero. The author endeavoured to find a more rigorous experimental proof of this conclusion than has hitherto been obtained. This was done by constructing a voltameter with platinum electrodes in which separate platinum wires were fused in close to the electrodes. Any polarisation of the latter due to a current, if leading to the formation of gas, would be gradually transferred to the wires through the separating liquid. This was found to be the case, and dissociation was obtained with E.M.F.s of a few hundredths of a volt.—Loss of energy in magnetisation by oscillatory condenser discharges, by Ignatz Klemenčič. Hysteresis and other losses have so far only been investigated with about a hundred oscillations per second. The author experimented with condenser discharges up to 2000 per second in order to obtain an approximate idea of the action of Foucault currents and hysteresis in iron and nickel at higher frequencies. The method used was that of discharging a condenser and interrupting its discharge at a certain stage by a dropping weight. This made it possible to determine the damping of the oscillations in a simple coil and in a coil with an iron or nickel core respectively. The results showed that even in thin iron wires the loss of energy was chiefly determined by the Foucault currents. The losses due to hysteresis in soft iron were considerably greater than those calculated from the hysteresis curves at lower frequencies. For steel and nickel, however, the losses were about the same.—On magnetic irregularity and the annealing of iron and steel, by A. Ebeling and E. Schmidt. Annealing, if done uniformly, may be sometimes useful ; but if not uniform, it may be detrimental to magnetic homogeneity. The most uniform material is obtained by careful fusion. Wrought iron is not made magnetically uniform by annealing.—Transparency of bodies for Röntgen rays, by O. Zoth. This was determined by comparing them with a tinfoil scale containing grades of various thicknesses. The transparency of alcohol compared with tin was 600, that of water 300, cork 2450, ebonite 150, plate-glass 29, magnesium 36,

aluminium 25, lead 0·29, gold 0·28, and platinum 0·25. The author also found a slight difference between the transparency of solid substances and their powders, which shows that there is some reflection or refraction. Loose powder was even less transparent than pressed powder.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 21.—"Note on the Larva and Post-larval Development of *Leucosolenia variabilis* H. sp., with Remarks on the Development of other Asconidæ." By E. A. Minchin.

The larva of *Leucosolenia variabilis* is an amphiblastula of a primitive type, transitional in many respects between the larva of the lower Ascons and the amphiblastula of the Sycons. It has an anterior ciliated, and a posterior non-ciliated pole, but when first hatched the ciliated pole is relatively very large, and the non-ciliated cells are few in number. During the free-swimming larval period the non-ciliated cells increase through their numbers being recruited from the ciliated cells, of which those situated more posteriorly become modified into granular cells after passing through an intermediate stage. In addition to anterior ciliated cells, posterior granular cells, and the equatorial zone of intermediate cells, the larva has cells of a fourth kind, placed in the centre of the body, immediately behind the minute central cavity, which contains gelatinous matter and is surrounded laterally by a ring of pigment lodged in the inner ends of the ciliated and intermediate cells. The central cells, together with the pigment, appear to constitute a larval organ, perhaps sensitive to light, which is lost at the metamorphosis.

The larva swims for 36-48 hours and fixes by the anterior pole. The granular cells grow round the ciliated cells, and the former become the dermal layer, the latter the gastral layer. At first the dermal layer forms an epithelium of a single layer, which becomes two-layered by immigration of certain of its cells. The dermal cells which remain on the surface secrete each a single monaxon spicule; those which migrate inwards arrange themselves into groups, and secrete the tri- and quadri-radiate spicules. While these changes are taking place in the dermal layer, a central cavity has appeared, round which the gastral cells arrange themselves in a columnar epithelium and gradually assume the characters of collar cells. At one spot the cavity is not lined by gastral cells, but by dermal cells only; it is here that the osculum is formed about the sixth day of fixation.

In the other Ascons investigated—*L. cerebrum*, *L. coriacea*, and *L. reticulum*—the larvæ are oval ciliated blastulæ in which an inner mass of cells is formed by modification and subsequent immigration of certain of the ciliated cells. In *cerebrum* and *coriacea* the immigration appears to be multipolar; in *reticulum* it takes place from the posterior pole, and thus affords a transition to the above-described larva of *variabilis*. If the cavity of the larva of *reticulum* be imagined reduced to the extent to which this has occurred in *variabilis*, then the modified cells at the hinder pole, instead of migrating inwards, must remain where they are, and as more ciliated cells become modified around them, a type of larva is obtained with ciliated cells anteriorly, intermediate cells laterally, and non-ciliated cells posteriorly, as in *variabilis*. This homology is further borne out by the fact that in all these larvæ the inner mass becomes the dermal layer, and the ciliated cells become the gastral layer, as the result of changes in position which take place at the metamorphosis. The post-larval development of the layers is similar to that described for *variabilis*.

When the development of *L. variabilis* is compared with that of Sycon as described by Schulze and Metschnikoff, it is seen that the only difference between them lies in the periods at which the events take place. In Sycon the larva, while still in the maternal tissues, undergoes changes which in *variabilis* take place during the free-swimming period, and the dermal cells surround the gastral cells before fixation in Sycon, instead of after fixation, as in *variabilis*.

The primitive larva of Calcarea was probably a ciliated blastula, in which an inner mass, the future dermal layer, was formed by modification and immigration of certain of the cells.

The immigration of cells from the dermal layer to form the triradiate spicules is precisely similar to what occurs in the adult whenever new spicules arise. Hence this process is not to be regarded as one of blastogenetic, but of histogenetic significance. In other words, sponges are to be regarded as two-layered animals, and not as possessing a mesoderm.

June 18.—"On Fertilisation, and the Segmentation of the Spore, in *Fucus*. By Prof. J. Bretland Farmer and Mr. J. Ll. Williams.

An account was given of an investigation into the mode of formation of the oospheres, of their fertilisation by the antherozoids, and of the germination of the resulting spores in various members of the Fucaceæ, special attention being paid to the protoplasmic structures therein concerned. The chief points were illustrated by lantern-slides from photomicrographs.

In order to study the fertilisation and germination stages, diœcious species were selected, and the male and female plants were kept in separate dishes, covered over so as to prevent drying up. This method gave far better results than those more usually advocated. On the appearance of the extruded sexual products, the female receptacles were placed in sea water, and after the complete liberation of the oospheres, a few male branches with ripe antherozoids were first placed in a capsule of sea water until it became turbid owing to their number. If on examination the antherozoids proved to be active, small quantities were added to the vessels containing the oospheres. The latter were then fixed at intervals of five minutes during the first hour, and then at intervals of fifteen minutes, up to six hours after the addition of the antherozoids. After that, samples were killed at longer intervals up to three days, and this was continued till we had material fixed at all stages for the first fortnight. At first sea water was used in which to keep the embryos growing, but a proper solution of Tidman's sea salt was found to answer quite as well. A large number of fixing reagents were tried, but Flemming's solution diluted with sea water gave the best results. Many reagents in common use proved utterly worthless. In embedding the tissues and spores in paraffin, previous to cutting them, it is important not to allow the temperature to rise above 50° C.

When an oogonial nucleus is about to divide, it first becomes slightly, then very much, elongated so as to resemble an ellipse. Fine radiations are seen to extend from the two ends into the surrounding cytoplasm. The latter is at first tolerably uniformly granular, but as the radiations around the polar areas increase, these regions become cleared altogether of the granules which then become massed outside them. The nucleus rapidly becomes more spindle-shaped, and its chromatic elements are chiefly grouped near each pole, leaving a clear space about the equator in which the nucleolus is situated.

The polar radiations continue to increase and the nucleus to lengthen, until the entire structure recalls the figure of a dumb-bell, in which the nucleus answers to the handle, and the radiation areas to the knobs. If the radii be traced outwardly, they are seen to terminate either in the frothy protoplasm, on the angles where the foam walls meet, or on the large granules which surround the cleared areas and are embedded in the foam. No structures were seen which could *certainly* be identified as centrosomes, although bodies suggestive of them were often observed; but these proved to be so variable in size and position, as well as in number, that it appeared impossible to attach any special significance to them.

The achromatic spindle is remarkable, inasmuch as it is intranuclear. The chromosomes were too minute to admit of their development being satisfactorily studied, but in all the *oogonial* spindles the number was estimated as *ten* when seen in profile. After the delimitation of the oospheres, some of them were observed to contain more than one nucleus. This is an abnormal feature, and the non-recognition of this fact has led to mistaken views in the past. When the oospheres are extruded, and come to lie free in the water, they swell somewhat, and are turbid with granules, which are very abundant in the cytoplasm. About five minutes after the mixing of the sexual cells, the antherozoids are found to have slipped into many of the oospheres. The act of penetration was not observed, but, in a number of cases, the antherozoid could be recognised within the oosphere, before its final fusion with the nucleus of the latter. It is a roundish, densely staining body, and, unlike the majority of animal sperm cells as yet described, no system of radiations are associated with it when in the egg. Judging from the short period of time elapsing between its penetration of the surface of the oosphere and its arrival at the exterior of the female nucleus, it must pass through the intervening cytoplasm with great rapidity. It then becomes closely appressed to the nucleus,

and is about as large as the nucleolus of the latter. It rapidly spreads over a part of the female nucleus as a cap, and it presents a less homogeneous aspect than before. Both it and the female nucleus assume a granular character, which is probably to be interpreted as representing a coiling and looping of the linin of the respective nuclei. Finally the two nuclei coalesce, and the original components can no longer be distinguished. Complete fusion may be effected in less than ten minutes after the addition of the antherozoids to the water.

A delicate pellicle is meanwhile formed around the periphery of the oosphere, which is thus easily distinguished from the unfertilised oospheres, in which such a membrane is wanting. The texture of the cytoplasm also changes, and tends to assume a more definitely radiating character, the lines starting from the nucleus as a centre.

After fertilisation, the cells rest for a long interval of time—commonly about twenty-four hours—before they begin to segment. The principal changes which occur during the interval are, first, in the rapid increase in the thickness of the peripheral cell wall, and, secondly, in the more regular arrangement of structure exhibited by the protoplasm. The alveolar or foam character is extremely clear, and the chromatophores, which by this time have become very prominent, are noticed to be situated in the angles formed by the convergence of the foam walls; they are often bent and otherwise distorted, and so accommodate themselves to the structural condition of the foam.

The first segmentation-division resembles, in a general way, the oogonial nuclear divisions already described. The achromatic fibrils forming the polar radiations are clearly seen to be attached to the foam-like structure of the cytoplasm, and, in some cases, insensibly to pass into it. At other times fibrils end on granules (or, perhaps, on the protoplasmic lining of the granules), and sometimes again a fibril may fork, and its branches end either on granules or on the foam angles. The interpolar portion of the spindle is intranuclear, and the chromosomes, when arrayed at its equator, are seen to be *twice as numerous* as those in the oogonial spindles. This doubled number is maintained throughout the thallus divisions, and the reduction in their number only occurs in connection with the actual differentiation of the sexual cells. The theoretical conclusions to be drawn from these facts were briefly indicated by the authors.

"Phenomena resulting from Interruption of Afferent and Efferent Tracts of the Cerebellum." By Dr. J. S. Risien Russell, Research Scholar to the British Medical Association.

Continuing his researches into the functions of the cerebellum, the author has directed his attention to the effects of dividing one inferior peduncle of this organ. He finds that in the disorders of equilibration which result, the direction of rotation is towards the side of the lesion, or, in other words, if, as was always the case, the left peduncle was divided, the animal rotated like a right-handed screw entering an object.

The disorders of motility which result from such a lesion correspond exactly with those observed after ablation of one lateral half of the organ, and consist in defective movement in the limbs on the side of the divided peduncle, and of the posterior limb of the opposite side. It is suggested that these effects may result from the interruption of afferent impulses passing to the cerebellum, rather than from the cutting off of efferent impulses from the cerebellum to the spinal centres. The interruption of similar impulses are held responsible for the displacement of both eyes downwards and to the opposite, a displacement which also resulted after removal of one lateral half of the cerebellum.

Spasm, which was easily detected in the back and neck muscles on the side of the lesion, causing incurvation of the vertebral axis to that side, alone furnished any satisfactory information in support of the view that the cerebellum exerts an inhibiting influence on the spinal centres; but the tendon reflexes afforded no satisfactory information on this point.

Sensibility was blunted on those extremities in which motor power was defective, a point in favour of the author's previous contention that the cerebellum is concerned with sensory as well as with motor processes.

The excitability of the cortex of the opposite cerebral hemisphere to the Faradic current was less than that of the hemisphere on the same side as the divided peduncle, a result which strengthens the view that one lateral half of the cerebellum exerts a control on the opposite cerebral cortex, as was suggested by certain results previously obtained by the author, and which further points to the possibility that the cerebellum is in its turn inhibited by afferent influences which reach it from lower centres. This view is made still more probable by the remarkable results obtained by the intravenous injection of absinthe after division of one inferior peduncle of the cerebellum, for during the otherwise general convulsions which resulted, there was a complete absence of convulsions in the muscles of the anterior extremity on the side of the lesion, and a diminution of the convulsions in the muscles of the posterior extremity of the same side.

These results were supplemented and controlled by other experiments in which the lateral tracts of the medulla oblongata were divided on one side without injury to the pyramid, by others in which the posterior columns and their nuclei were divided on one side, and by others in which partial hemisection of the medulla was performed, including all the structures on one side with the exception of the pyramid.

PARIS.

Academy of Sciences, July 13.—M. A. Chatin in the chair.—On the flow of liquids in large rectangular channels, and in pipes or canals of circular or semicircular section, by M. J. Boussinesq.—On the law of corresponding states of Van der Waals, and the determination of the critical constants, by M. E. H. Amagat. Some applications of the method of projection described in a previous note. Taking the critical constants of any one substance, the determination of which may be looked upon as the most trustworthy, the critical constants of any other substance may be determined in terms of these from the experimental pv curve.—On a new method for the determination of the respective distances of the centres of cerebral localisation, by M. C. Henry.—Remarks, by M. Langlois, on a new theory of capillarity.—On the fixing of photographs in colour on paper, by M. A. Graby.—Aërial navigation, by M. L. Gardère.—On differential equations of the first order, by M. P. Painlevé. A reply to a note of M. Korkine.—On groups of substitutions, by M. G. A. Miller.—On the function $\zeta(s)$, by M. Hadamard. Pointing out that a part of a proof given in a preceding note is not rigorously true.—On the displacement of the axis of rotation of a solid body of which a part is rendered instantaneously mobile with respect to the rest of the mass, by MM. Edmond and Maurice Fouché.—On the elastic equilibrium of a revolving body, by M. L. Lecornu.—On a graphical representation of luminous waves, by M. G. Vert.—On the verification of the theorem of corresponding states, by M. C. Raveau. By taking the logarithms of pv and p as co-ordinates, instead of pv and p, the method suggested by M. Amagat is much simplified in its application.—On an absolutely astatic galvanometer of high sensibility, by M. A. Broca.—On the vaporisation of metals at the ordinary temperature, by M. H. Pellat. Results similar to those obtained by M. Colson with zinc are obtainable with steel. In view of the experiments of M. Becquerel with metallic uranium, it is suggested that similar invisible radiations, and not the vapour of the metal, may produce the effects observed.—Method for photographing in reverse, objects in relief, by M. E. Moussard.—On the manner in which the X-rays cause the discharge of electrified bodies, by M. Émile Villari. Some experiments tending to show that the discharge is due to convection currents in the air surrounding the charged body.—The action of tubes and metallic discs upon the X-rays, by the same.—The action of the Röntgen rays on the diphtheric bacillus, by M. F. Berton. No attenuation of the virus could be obtained by exposure to the rays for forty-eight hours.—On the fusibility of metallic alloys, by M. Henri Gautier. A study of the fusibility curves allows of the prediction of the existence of the following alloys of definite composition: Ni_3Sn_2, $SnAl$, Ag_2Al, and $SbAl$, the last of which was isolated by C. Alder Wright.—Diamonds in steel, by M. Rossel.—Action of silicon upon certain metals, by M. E. Vigouroux. The alkali metals, zinc, aluminium, lead, tin, antimony, bismuth, gold and silver dissolve silicon more or less, but do not combine with it directly. Iron, chromium, nickel, cobalt, manganese, copper and platinum, on the other hand, form definite silicides.—Researches on the double cyanides, by M. R. Varet.—Action of water upon formic aldehyde, by M. Marcel Delépine. Formic aldehyde with water at 200° gives CO, CO_2, formic acid and methyl alcohol.—Reduction of crotonic aldehyde, by M. E. Charon. By the use of the

zinc-copper couple in acetic acid solution two unsaturated alcohols are obtained :

$$CH_3.CH : CH.CH_2.OH$$

and

$$CH_3.CH : CH.CH(OH).CH(OH)CH : CH.CH_3.$$

—Rapid estimation of carbon dioxide in the air and confined spaces, by M. Henriet. The gas is absorbed in potash, and the latter titrated with sulphuric acid, using phenol-phthalein as indicator.—Termination of the muscular sensory nerves on the striated bundles, by M. C. Rouget.—On the electroneuromuscular circuit, by M. E Solvay.—Cutaneous evaporation in the rabbit. Modifications under the influence of electrical excitement, by M. Lecercle. Under the influence of galvanisation the cutaneous evaporation is increased.—On the order of succession of the fauna of the Upper Lias near Luçon, by MM. Chartron and Welsch.—On the topaz crystals of Perak, by MM. A. Lacroix and Sol.—On the estimation of gluten in flour, by M. Balland.—On the treatment of such diseases as gout and diabetes by high frequency currents, by M. Vigouroux.—On the results furnished by orchitine in the treatment of leprosy, by M. Bouffé.

PHILADELPHIA.

Academy of Natural Sciences, June 23.—Rev. H. C. McCook reported a series of observations on the California trapdoor spider, *Ctenisa Californica*, made by Dr. Davidson, who has been able to determine the time required for the construction of the burrow in confinement, and other matters connected with the life-history of the animal. It has taken ten hours to construct the nest with its hinged door, another spider having made a hole large enough to conceal itself in two hours. The method of digging was the same in the main as that described by Dr. McCook for the tarantula. The young, when they emerge, at once build their own miniature nests, which are renewed every spring until they reach the full size. Based on the study of a Lycosid, the speaker had predicted that the enemy of the trapdoor spider would be found to be a diurnal wasp. Dr. Davidson had established the fact that such is the case, and that the attacking species is *Parapompilus planatus*, Fox.—Mr. H. C. Mercer made a report on his recent exploration of certain caves in Tennessee, which he had been able to prosecute under the patronage of the University of Pennsylvania, mainly through the liberality of Dr. William Pepper. In Zirkel's cave on Dumpling Creek, Jefferson County, Tennessee, crusts of breccia projected from the walls and hung from the roof. From this material the teeth of the tapir, peccary, &c., projected, while in the cave below were found bones, nuts, two pieces of Indian pottery and fragments of mica, probably indicating Indian burial cave. There were therefore two ages indicated : one ancient, by the breccia, and the other, the cave earth, comparatively recent. All the fossil remains belonged to the breccia, and there was no association between them and the indications of human life. Another cave on the Tennessee River, under Lookout Mountain, Hamilton County, Tennessee, presented a floor of two layers, the black top one, of three or three and a half feet in thickness, composed of Indian remains, and another of yellow earth containing a few animal remains but no indication of human existence. Mylodon and Tapirus fragments, found some time ago close to the bottom of the upper layer, had probably been scraped up from the lower. Neither, therefore, did this cave present any certain data for the advancement of the date of man's antiquity. On the contrary, the evidence supported the belief that pleistocene or palæolithic man had not existed in that region. On penetrating the forbidden entrance of Big Bone Cave, near Caney Fork River, Van Buren County, Tennessee, he had found, nine hundred feet in, the bones of *Megalonyx* still bearing articular cartilages. Fragments of torches were found beneath the sloth bones, probably buried by burrowing rats. Prof. E. D. Cope commented on the fossil bones collected in the caves described by Mr. Mercer. The presence of cartilages on the *Megalonyx* bones indicated for them an age certainly not more remote than the existence of man on this continent. Other bones belonging to young individuals were larger than corresponding ones found at Port Kennedy, indicating the validity of the two species: *Megalonyx Wheatleyi* and *M. Jeffersonii*. Mr. Mercer had also collected remains of fifteen or twenty species of birds, six fishes, one batrachian, four tortoises, one rattlesnake, and nineteen mammals. The special value of Mr. Mercer's careful work was commented on. The peccary is found in Zirkel's cave, although no trace of it appears in the Lookout Mountain cave. Several undescribed species were indicated.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Catalogue of the Fossil Bryozoa in the Department of Geology (Natural History): Dr. J. W. Gregory: The Jurassic Bryozoa (London).—Glasgow and West of Scotland Technical College, Calendar for the Session 1896-7 (Glasgow).—The Biological Problem of To-day: Dr. O. Hertwig, translated by P. C. Mitchell (Heinemann). Die Formen der Familie und die Formen der Wirthschaft: E. Grosse (Freiburg, Mohr).

PAMPHLETS.—Tesi de Fisica e Meccanica: G. Casazza (Milano).—Field Columbian Museum, Annual Report for the Year 1894-95 (Chicago).—Fiftieth Annual Report of the Director of the Astronomical Observatory of Harvard College: E. C. Pickering (Cambridge, Mass.).—Die Saturniiden: A. R. Grote (Hildesheim).

SERIALS.—Records of the Geological Survey of India, Vol xxix. Part 2 (Calcutta).—Indian Museum Notes, Vol. 3, No. 6; Vol. 4, No. 1 (Calcutta).—Science Progress, July (Scientific Press).—Journal of the Royal Microscopical Society, June (Williams).—Annals of the Astronomical Observatory of Harvard College, Vol. xl. Part 4; Vol. xli. No. 3; Vol. xxxiv. (Cambridge, Mass.).—Journal of the Academy of Natural Sciences of Philadelphia, 2nd series, Vol. x. Part 3 (Philadelphia).—Lloyd's Natural History. Cats, Civets, and Mungooses: R. Lydekker, Part 1 (Lloyd).—Psychological Review, July (Macmillan).—Bulletin de l'Académie Royale des Sciences de Belgique, 1896, No. 5 (Bruxelles).—Journal of the Royal Statistical Society, June (Stanford).—Journal of the Franklin Institute, July (Philadelphia).—American Journal of Science, July (New Haven).—American Naturalist, July (Philadelphia).—Zeitschrift für Wissenschaftliche Zoologie, lvi. Band, 3 Heft (Leipzig, Engelmann).—Strand Magazine, July (Newnes).—Quarterly Review, July (Murray).—Proceedings of the Physical Society, Vol. 14, Part 7 (Taylor).—Lean's Royal Navy List, July (Witherby).—Engineering Magazine, July (Tucker).—Annales de l'Observatoire Astronomique de Moscou, deux série Vol. 3, Livr. 2 (Moscou).—Journal of Anatomy and Physiology, July (Griffin).—Bulletin of the American Mathematical Society, June (New York, Macmillan).—Memorie della Società Geografica Italiana, Vol. vi. Parte Prima (Roma).—Lloyd's Natural History. Cats, &c.: R. Lydekker, Part 2 (Lloyd).—Zeitschrift für Physikalische Chemie, xx. Band, 2 Heft (Leipzig, Engelmann).—Transactions of the Royal Society of Edinburgh, Vol. xxxvii. Parts 3 and 4; Ditto, Vol. xxxviii. Parts 1 and 2 (Edinburgh, Grant).—Proceedings of the Royal Society of Edinburgh, Vol. xxi. No. 1 (Edinburgh).—Archives of Clinical Skiagraphy, No. 2, Vol. 1 (Rebman).

CONTENTS.

THURSDAY, JULY 30, 1896.

INDUSTRIAL PHOTOMETRY.

A Treatise on Industrial Photometry, with special application to Electric Lighting. By A. Palaz, Sc.D. Translated from the French by G. W. Patterson and M. R. Patterson. Pp. x + 322. (London: Sampson Low and Co., Ltd.)

IT is remarkable, considering the importance of artificial methods of illumination, that there is so little literature dealing with the subject of light measurement treated from an industrial point of view. The introduction of electric lighting, and still more recently the success of the incandescent gas system, have aroused in the public a demand for more powerful methods of illumination than formerly were found to satisfy. But the problems involved in the economical arrangement of artificial light sources are very little understood. The scientific aspect of the subject has, indeed, hardly advanced at all during the last few years. Electrical engineers have made great efforts to increase by one or two per cent. the efficiency of dynamos intended for electric lighting purposes; but the study of arrangements of lamps and reflectors, to produce the best effect, has been almost ignored, with the result in many cases of losing quite half the usefulness of the light. There are in fact many problems involved in the economical distribution of lights, the importance of which is little recognised, and the solution hardly yet discovered. They are not to be found in text-books, and are only alluded to in isolated papers scattered about in the technical journals. The present work is a valuable compilation of facts and experiments obtained from the best technical authorities; and is the only book we know of in which this information can be obtained. The matter has not been hastily put together, since the book is a development of a long series of articles published by the author in *La Lumière Électrique* in 1887, and now enlarged and brought up to date.

The work is divided into six chapters, the first of which is introductory and deals with the principles of the subject. It contains some useful information, but is disfigured by an unfortunate choice of terms. The *candle-power* of a source of light, or the quantity of light emitted by it per unit solid angle, is here denoted by the objectionable term *total intensity*. Now the candle-power of a candle, like the horse-power of a horse, may vary from time to time; but whatever the vagaries of a so-called standard candle, the term candle-power is quite scientific. To replace this simple, accurate, and much-used expression by a vague, misleading, and unknown term, is most unfortunate, especially since, with all ordinary light sources, the candle-power varies with the direction considered, and one has to try and realise what the mean-spherical-"total"-intensity of a light source may be. The translators have, in fact, reproduced too literally the author's word intensity, which turns up over and over again in quite a needless fashion, as for instance in the phrase *intensity of illumination*, which is used to denote the quantity which English writers generally denote by the single word *illumination*. It is a great pity to make this latter word synonymous with quantity of light, as is done in this book. The ordinary idea conveyed in the assertion that an area is well illuminated, is not that there is a large quantity of light falling upon it, but that the quantity falling on it *per unit area* is considerable. The word illumination when used scientifically should correspond with this popular, and also precise, meaning. It should denote the density of the flux, not the flux itself, as the translators have unfortunately made it do.

The second chapter, on photometers, is a most valuable one. It is the longest in the book, and, like all the other chapters, is well illustrated. Photometers are divided into six classes, and over forty are described. The information given is by no means confined to instrumental details, for matters connected with the theory and practical use of the apparatus receive a good deal of attention. For instance, many useful details of various modes of making Foucault and Bunsen screens are given, and the theory of the Bunsen photometer is very fully discussed. It is remarkable how complicated this theory becomes when examined, and it does not appear that the theory given is too elaborate. As a matter of fact the optical properties of diffusing screens have been very little studied, and what has really been done in this direction seems to show that they cannot be treated in so simple a manner as is here assumed. This chapter is a useful summary of the different varieties of photometers, and leaves little to be desired. Naturally some of the instruments alluded to are of small value, while others depend on principles of a debatable character. This is especially the case in connection with heterochromatic photometry, a subject on which opinions seem to differ widely. The author is inclined to dissent from Helmholtz' assertion that "of all the comparisons effected by the aid of the eye between the intensities of different sorts of composite light, there is not one which possesses an objective value independent of the nature of the eye." Apparently many disagree with this view, since several photometers are described in which the judgment of the eye is only appealed to after the contending lights have been subjected to elaborate processes, which make it doubtful whether the decision obtained has any reference to their illuminating powers. Helmholtz' view seems to be the true one after all, and in fact it is difficult to dispute it in view of the property of the eye known as Purkinje's phenomenon, according to which the ratio of the illuminating powers of two lights of different composition varies if the intensity of each light is reduced in the same proportion. There is, no doubt, something to be said for adopting methods of comparison independent of the eye, owing to the fact that not only do two observers differ from one another, but a single observer obtains different results at different times. This, however, is largely a matter of practice, and we believe that Captain Abney, and others who have worked much at colour photometry, make little of the difficulty of judging when two illuminated surfaces of different colours are equally luminous. Certainly some of the photometers described here seem of doubtful value, in spite of the skill shown in their design, owing to the number of constants which have to be determined experimentally for each instrument; these constants apparently depending not only on the instrument, and the person using it, but also to some extent

upon the nature of the lights to be compared. The most hopeful of all the instruments described for colour photometry seems to be the mixture photometer of Grosse. In this instrument the lights A and B, to be compared, are estimated not by directly measuring the ratio A : B, but by comparing two mixtures, A + *m* B and *n* A + B, where *m* and *n* are constants fixed for each instrument. Here the colour difficulty is got over by mixing the lights, and the relative illuminations of the surfaces compared is varied, partly by adjusting the distances of the lights, and partly by turning the eye-piece of the instrument, the working of which depends on the phenomena of polarisation. As far as one can judge from the description, this photometer appears to be an excellent one.

The third chapter, on photometric standards, is a full and trustworthy account of the efforts which have been made at different times towards obtaining a good standard of light. Its usefulness is increased by plentiful references to original papers, as is the case with the other portions of the book. The French work was published too soon to include the final results of the work of the English Committee on Light Standards, but almost all previous work is alluded to. A short, but good, chapter on the equipment of photometric laboratories is succeeded by one entitled "electric lights," which contains a large amount of photometric matter relating to electric lighting, that has not hitherto appeared in book form.

The sixth and last chapter of the book is reserved for the distribution and measurement of illumination. As illumination is the whole object of artificial lighting, it seems strange that the consideration of it should have been so much neglected. For every photometer that has been designed for the measurement of illumination, there are at least twenty for the measurement of candle-power. The present book is, we believe, the first to take up this subject as an important part of photometry; and the ordinary reader, who has not followed the subject in the technical press, will find here much which is quite new to him. It is a subject of increasing importance, and since the issue of the French edition of this book some valuable work on it has been done by Trotter and Blondel, which should be incorporated when a new edition is called for. It is somewhat remarkable that no allusion is made to the diffused system of lighting by inverted arc lamps, or corresponding arrangements of glow lamps, in which the lights themselves are hidden from view, the rays being directed to walls and ceilings for subsequent diffusion downwards. This system has been used on the continent and in this country, especially for the lighting of factories, and its use is extending. It is in reality one of the most efficient systems of lighting, although any one seeing it for the first time is apt to think it weaker than it really is. A description of it should certainly find a place in a book such as this. There is, however, a large amount of new matter given in this chapter, and the only fault to find is a minor one, and one for which the author is not directly responsible. In quoting the different writers on this subject, a number of terms have been introduced which are needless, confusing, and badly chosen. Such terms as "volume of illumination" and "surface of illumination" are quite needless, while the phrase "useful effect of illumination" is a very bad and misleading name for a quantity which is of doubtful importance. It follows from the definition that the "useful effect of illumination" is always greater than the illumination itself, and that it increases rapidly as the distance from the light is increased, until at an infinite distance from the light the "useful effect" of its illumination is infinite. "This result was easy to foresee," writes the author, who asserts that the criticisms to which it has been subjected "are not well founded"; and calculations are then made by means of which "the volume of useful effect," the "surface of useful effect," and the "mean useful effect" may be obtained by any one anxious to know.

In spite of a few minor blemishes, the book is a thoroughly good one. It is well printed, well illustrated, and contains a mass of valuable matter which is not to be found elsewhere. Some useful appendices by the translators conclude the work.

W. E. S.

THE NOTES OF BIRDS.

The Evolution of Bird-song. By Charles A. Witchell. Pp. x + 348. (London: A. and C. Black, 1896.)

THIS little work will be heartily welcomed by all ornithologists as the first elaborate attempt to deal in a scientific spirit with the very difficult subject of the utterances of birds. Considering the great amount of careful observation necessary to the formation of any theory on the subject, and the difficulty of recording such observation correctly and intelligibly, Mr. Witchell is to be warmly congratulated on his book. It is, in fact, a very welcome and agreeable call-note, addressed to h brethren of the craft, and urging them to come and test the flavour of the food its author has discovered. Should any of them be critical of details, as indeed in such a subject they inevitably must be, it is to be hoped that the call-note will not change into an "alarm"; for however much we may differ from Mr. Witchell in detail, we shall hardly be disposed to quarrel with the main line of his argument, and we shall be grateful to him for his work as a pioneer. Personally I am glad to acknowledge that during the present season of song I have derived the greatest benefit from this book, which fortunately appeared at the very time when fresh observation was most easy and agreeable.

Starting with Darwin's theory of the origin of voice, Mr. Witchell states his belief that it was first occasioned by fear or anger in combat, and that, consequently, the earliest cries were alarm-cries. He then proceeds to show that "the first call-notes of birds were probably mere adaptations of alarm-cries, the use of which was induced by the influence of mutual aid among associated individuals." Rapid reiteration of call-notes had a tendency to produce something in the nature of song; and Mr. Witchell is able to produce several good examples of this in species which are still incapable of any true vocal effort, though he gives one or two, *e.g.* the willow-warbler, about which I feel, as yet, uncertain. Closer observation on this point is much wanted, but I can quote one case, that of the tree-sparrow (not mentioned by Mr. Witchell), which may occasionally be heard in the spring constructing a quasi-song by linking call-notes together. Mr. Witchell is careful not to commit himself to the view

that *all* songs were so developed; but it is quite possible that this view may eventually hold the field, if due credit be given to the inventive and imitative powers of the bird, which, having once found a voice, would naturally make constant use of it and thus develop its resources. As regards imitation, he has much to say later on; but throughout the book he seems to me to neglect what I should call *invention*, or the varying use of the voice for the mere pleasure of using it. I am pretty confident that many birds will go on uttering "call-notes," and even songs, not for any special immediate purpose, but to express a certain sense of comfort, and for the pleasure derived from the effort. A good example of this is the greenfinch, a bird in the interpretation of whose notes Mr. Witchell surprises me; but want of space forbids me to enter into details.

Next follows a chapter on certain noticeable incidents of bird-song, which may be strongly recommended to those who are beginning to make observations of the utterances of birds. They will find their attention directed to such points as this: that variation from the specific type of song is generally to be heard at the end of the phrase, and, conversely, that the first part of the phrases sung by allied birds have the most resemblance to common types. Or, again, that the call-notes and alarms of allied birds are more alike than are their songs—a point of great importance. A theory (p. 70) to account for the fact that the most voiceful birds are, as a rule, small, is also worth consideration.

But it is in the last three chapters that we find the most original and interesting contributions to the subject. Of these, chapters vii. and ix. are on the influence respectively of heredity and imitation, and between them the author has placed a shorter one on variation. The chapter on heredity, though it would be the better for a thorough revision, both in the ordering and expression of the matter, is nevertheless of great importance. Here Mr. Witchell endeavours with success to trace the influence of the principle of heredity by comparing the notes and songs of allied species, so as to provide fresh scientific reasons for their connection in classification. As might be expected, he finds more to the purpose in call-notes and alarms than in songs, and more in the first phrases of song than in the conclusions. Some things in this chapter may astonish us, such as the statement that the buntings are more closely allied by voice to the pipits than to the finches (p. 121), and the whole of a paragraph on p. 113, in which the songs of nightingale, lesser whitethroat, and cirl-bunting are declared to resemble each other; but the general value of this part of the work is beyond question, and cannot fail to act as a fresh stimulus to many field ornithologists.

In chapter ix. Mr. Witchell discusses his second leading principle in the development of song, viz. imitation, whether of the voices of other birds, or of prevalent sounds in fields and woods. This is, I think, his favourite topic, and the one which he has most carefully elaborated by observations and records. He has gone far beyond any previous writer in the wide range of result he ascribes to this influence, and his conclusions as to the imitative capacity of many species will have to be most carefully tested. For the last two months I have been endeavouring to test them with varying result. As regards the thrush and the robin, he has already convinced me that they mimic much more than I had suspected, though I cannot detect in these songs more than an occasional imitation of which I can be *quite certain*. In others, such as those of nightingale, redstart, whitethroat, &c., I can as yet hardly detect any at all, though I have been listening to these voices constantly and carefully for more than twenty years. As far as my own experience goes, I should be disposed to think that Mr. Witchell often exaggerates superficial and accidental resemblances; but on the other hand, I can readily grant that his ear may be more accurately trained than mine for the purpose of detecting them. And in any case I must refrain from detailed criticism, which can be but the pitting of one man's experience against that of another.

The short chapter on variation might well be amplified. Not only do many birds show dialectic variation in different localities, but in the same locality the singers vary from each other, and even the individuals constantly vary from one minute to another, as I have often observed this spring. And yet the specific type is always preserved, which is owing in great degree to the peculiar tone or *timbre* of the vocal instrument of the species—a point to which I hope Mr. Witchell will turn his attention more closely than he seems yet to have done.

It gives me pleasure to sign a notice in which I hope I have done justice to the merits of this work, for in a book published a year and a half ago, I alluded to Mr. Witchell's theory, as it was then known from papers in the *Zoologist*, with somewhat scant respect. Some fanciful conclusions to which he formerly gave prominence, have in this volume retired modestly into the background.

W. WARDE FOWLER.

THE STRUCTURE OF MAN.

The Structure of Man: an Index to his Past History. By Prof. R. Wiedersheim, translated by H. and M. Bernard. 8vo, pp. xxi + 227. (London: Macmillan and Co., 1895.)

THIS book, which is a translation of Prof. Wiedersheim's "Der Bau der Menschen," by H. and M. Bernard, has the advantage of a preface and notes by Prof. G. B. Howes. As the preface states, the object of the work "is an endeavour to set forth the more salient features in the anatomy of man which link him with lower forms, and others in that of lower forms which shed special light on parts of the human organism." Such books as this give to the scientific study of anatomy much assistance by calling attention to the interesting deductions which may be made by a careful study of the different variations met with in the dissection of man and animals. In order that such deductions may be placed on a firm basis, it is necessary to have careful observations recorded in a very large number of cases, and in the English preface of Prof. Wiedersheim's book a special tribute is paid to the work carried out in the different anatomical schools through the "Collective Investigation Committee of Great Britain and Ireland." The English translation has in a great many places been added to, and brought up to date in notes by Prof. Howes. Some of these additions are exceedingly valuable in themselves, and further, their

practical use is increased by the fact that they give references to the most recent literature on the subjects with which they deal. The plan of the book has been well thought out, and its arrangement is such as to render the search for information contained in it an easy one. Special chapters are set apart for the integument and tegumental organs, the skeleton, the muscular system, the nervous system, the sense organs, the alimentary canal and its appendages, the circulatory system, and the urinogenital system. The arrangement of the matter in each of these chapters is further carefully classified. In certain places the terms used lack the accuracy which is essential to a work on human anatomy, thus (p. 91) on the "comparison of the fore- and hind-limbs of man," to speak of the leg and arm of the adult as "opposite extremities" is vague and inaccurate. Again, in the description of the lower end of the humerus (p. 77) confusion is caused by the application of the term "ent-epicondylar" foramen to the occasional perforation of the olecranon fossa, instead of confining this name for the foramen partially enclosed by the ent-epicondylar process, which is sometimes present in man. The theories put forward in some parts of the book to account for facts observed in man, seem scarcely adequate; thus, for instance, on p. 38 we are told "the shifting of the centre of gravity towards the dorsal side explains why the vertebral ends of the lowest ribs are so firmly attached." Yet a very similar condition of the more posterior ribs obtains in quadrupeds, in which animals a shifting of the centre of gravity towards the spine does not occur. In another place (p. 55) it is stated that in lower races, as in the apes, the process of obliteration of the cranial sutures beginning in the frontal region and proceeding backwards "naturally causes an earlier limitation in the growth of the anterior lobes of the brain; whereas in the higher (white) races, when the fronto-parietal suture disappears only after the obliteration of the parieto-occipital one, these lobes are capable of further development." The obliteration of the sutures in the frontal region does not necessarily limit increase in growth of the frontal bones, much less that of the contained brain, and further, it has been shown that the frontal lobes do not in their growth vary with the changes in position of the fronto-parietal suture. The posterior boundary of the frontal lobe—fissure of Rolando—has a relatively constant position during brain growth, so that a relative increase in size of the frontal lobes, in white races, does not take place during the time that certain of the cranial sutures are closing, or even after birth. In the chapter on the nervous system, it is a pity that the old and superseded observations of Möller are retained, and we read, "Man differs from the Anthropoids in the preponderance of the frontal lobe and, to a lesser degree, of the occipital lobe, and in a corresponding backward extension of the temporal lobe. The parietal lobe is about equally developed in the brains of man and Anthropoids" (p. 131). As a matter of fact the great extent of the parietal lobe, together with a corresponding decrease of the occipital lobe, is a human characteristic. In the Anthropoids the upper part of the posterior boundary of the frontal lobe is relatively further back than in man. It is a curious fact that Prof. Wiedersheim's book should adhere to the old view, that a well-marked occipital lobe is a human characteristic, since it has been definitely shown that this part of the brain, which was at one time denied to apes, really attains in them its greatest relative development, and further, it is in the lower apes that a maximum is reached.

The presence of numerous illustrations, and of a glossary of the zoological terms used, in spite of its many failings, is sure to render this interesting and easily read translation of Prof. Wiedersheim's book very popular.

A. F. D.

OUR BOOK SHELF.

The Official Guide to the Norwich Castle Museum. By Thomas Southwell, F.Z.S. Pp. 294. (London: Jarrold and Sons, 1896.)

"THE value of a museum will be tested not only by its contents, but by the treatment of those contents as a means of the advancement of knowledge." This remark of Sir William Flower's is the key-note of the Committee of the Norwich Castle Museum, and in consonance with it the admirable guide-book at present before us has been constructed. The book is an interesting and useful guide to the collections in the Museum; it is not merely a catalogue, but a popular natural history in which the specimens in the cases are used as illustrations. Assisted by this guide, sightseers will pleasantly acquire a knowledge of the leading characteristics of the different groups of animals, and students will gain a large amount of sound instruction.

The scientific value of the book lies in Mr. Southwell's orderly review of the natural history specimens in the Museum. This forms the greater part of the contents; but there is also an historical account, by the Rev. Wm. Hudson, and a description of the collection of pictures, by Mr. G. C. Eaton.

The Museum was founded in 1825, and it existed as a private institution until 1894, when it was taken over by the Corporation, and established in Norwich Castle. The scheme for the conversion of the Castle, which had been condemned as a prison by the Prison Commissioners, into a museum and recreation grounds, was due to Mr. John Gurney, who died in February 1887. Mr. Gurney gave £5000 towards the scheme, which nucleus was afterwards increased by subscription to £14,389. The new home of the Museum collections was opened two years ago, and it is a credit to the Norwich Corporation and people. Very few local museums are better arranged than the one at Norwich, and in none is the educational object of the institution kept more in mind. To say that Mr. Southwell's guide is worthy of the Museum is, therefore, equivalent to stating that it possesses all the features which will make its readers appreciate to the fullest extent the *utile et dulce* of the collections.

Latitude and Longitude: How to Find them. By W. J. Millar. (London: Charles Griffin and Co., 1896.)

IN this concise little book the art of navigation is treated from an elementary standpoint. Commencing by explaining the meaning of a few mathematical expressions, including triangles, the author goes on to trigonometrical ratios and logarithms, and shows how they are brought into use for the purpose of finding a ship's position. The errors that have to be corrected are explained, as well as the determination of time and the use of the sextant.

The theory of the every-day work at sea, and also of lunar distances and Sumner's method, is given, so that with a small amount of mathematical knowledge a student of navigation can master the chief problems required to find the latitude and longitude at sea.

O. L.

LETTERS TO THE EDITOR.

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The Utility of Specific Characters.

I HOPE that my friend Prof. Lankester will forgive me if I find myself unable to accept the version which he has published of a portion of the remarks which I made at the recent discussion at the Linnean Society.

I entirely agree with Mr. Mivart, that the "Problem of Utility" really involves the validity of the Darwinian theory.

I stated in my remarks what I have often stated before, that I was more and more confirmed in the belief that specific characters in flowering plants are utilitarian. I showed that this was obviously so in familiar cases. If time had allowed, I might have strengthened my position by reference to the large amount of important and convincing work which has been done in this direction in other countries. At home, for reasons which are not far to seek, this kind of research is now almost entirely neglected. The result is that the Darwinian theory of organic evolution seems hardly to have a convinced supporter left except Mr. Wallace. In its place we have the "Physiological Selection" of Dr. Romanes, the "Discontinuous Variation" of Mr. Bateson, and, last of all, the extended "Correlation Principle" of Prof. Lankester. A common feature of each is their more or less definite rejection of the principle of utility as accounting for specific characters.

I was examining with Mr. Darwin, at Kew, a collection of Pitcher-plants (*Nepenthes*). The specific differences lie mainly in the appendages of the pitchers. I hazarded the remark that it seemed hopeless to attempt to explain these on teleological grounds, and that it was difficult to believe that the differences were not due to merely fortuitous variation. Mr. Darwin replied, that he was not prepared to admit it. He gave two reasons: (1) that many plant-structures which at first sight it was scarcely conceivable could be adaptive, had been proved to be so in the most unexpected manner; (2) that to assume that phenomena were not susceptible of explanation, was to shut the door to discovery.

Now I stated, perhaps unnecessarily, that the two reasons were not on the same plane. The first implicitly asserts an inductive principle, the probability of which, it seems to me, subsequent research confirms every day; the second, I described as of a moral kind. It would have been better to have spoken of it as *ethical*, or as a counsel of scientific prudence. In point of fact, I never used the word "immorality": that was imported into the discussion, and I think in a somewhat sarcastic spirit, by Prof. Lankester himself.

A more serious point, however, is this. Prof. Lankester quotes me as the authority for the statement that Mr. Darwin "appears to have deprecated . . . the invocation of this theory of correlation as an explanation of cases of apparently useless parts in animals and plants." Now I made no reference whatever to correlation, which I do not think enters into the particular case I referred to. The question I put to Mr. Darwin amounted simply to this:—"Is it probable that these specific differences will turn out to be adaptive?" And his reply was, in effect: "I think it is."

I confess that the use to which Prof. Lankester has turned the correlation principle fills me with some surprise. As with every difficulty which is from time to time brought up against the Darwinian theory, it will be found that Mr. Darwin has thoroughly considered the matter himself, and has said pretty much all that is to be said about it. The whole subject is exhaustively discussed in the twenty-fifth chapter of "Animals and Plants under Domestication." He treats at considerable length "the cases in which we can partly understand the bond of connection," and then gives more briefly "the cases in which we cannot even conjecture, or can only very obscurely see, what is the nature of the bond." This is characteristic of Mr. Darwin's fairness; he adopted precisely the same method in regard to cases which seemed to make for Lamarckism, and were not readily explicable by the principle of natural selection. Most of these have been since cleared up, and I do not doubt that the same thing will happen in regard to correlation. The *nexus*, which is now obscure, will sooner or later be revealed.

The animal organism is a "complex" which, in the vast majority of cases, we are far from understanding. It has undergone in a high degree what Mr. Herbert Spencer calls "integration." It is not surprising, therefore, that organic correlation has been obscured. Prof. Lankester lays it down, that "presumably also plants" are in the same predicament. But I do not admit this. In plants integration has not been carried to anything like the same extent. For many purposes of biological research I therefore hold with Mr. Darwin, that plants are better subjects of investigation than animals, because the phenomena are less complex.

The result is that in plants most cases of correlated variation are at once explicable. All the appendicular organs are homologous. A variation which affects one runs through the whole. Amongst many thousand Snowdrops from Asia Minor, grown at Kew this spring, a few had exceptionally broad leaves; this was accompanied by a corresponding dilatation of the perianth-segments. There is a variety of the common oak with marbled foliage. A tree at Tortworth has borne acorns, and these are striped. At first sight it might seem odd that a variation in foliage and fruit should be correlated. But it is not so: the marbling is due to the partial suppression of chlorophyll in those portions of the ground-tissue which are exposed to light; and this tract of tissue is continuous in the leaves and the carpels.

I cannot but think that even in animals, of which I know little, Prof. Lankester is building on a rash foundation in attempting to generalise widely from cases in which, in the light of present knowledge, the obvious but, as he thinks, useless distinctive character may (or may not) be linked with the unobvious adaptive variation.

It seems to me that when an explicable correlation persists in a species, we are not justified in assuming any part of the chain to be useless. The whole is, in fact, part of the specific character; and this was what I took to be Prof. Weldon's point. I do not see that our ignorance of the nature of the "bond" makes any difference; nor do I see how Prof. Lankester extricates himself from the effect of his admission that the parts of the chain are always subject to selection. It seems to me that we are justified in inferring that what survive as specific differences do so because they are useful.

I doubt if the case which has so impressed him is a very satisfactory one. He thinks that in "tropical regions" the colour of the skin is linked with the chemical activity of the leucocytes in the blood. Assuming that immunity from fever is due to the latter, he infers that the former is not a "useful character." This is, in the present state of our knowledge, taking a good deal for granted. But I frankly admit that such a case, if completely established, would give the utility of specific characters, and with it the Darwinian theory, a serious blow; and Prof. Lankester would have the satisfaction of arriving at the same result as Dr. Romanes, but by a different path.

But is he sure of his ground? Mr. Darwin touches on the connection between "complexion and constitution," but does not appear to think the evidence points to any definite conclusion. Nor, I confess, do I, from such facts as are within my knowledge. I have sent a good many men from Kew to Africa, and the belief of my staff is that fair men enjoy better health than dark. But I do not consider that the data are sufficient. On the other hand, men of African descent, transferred from the West Indies to Africa, are said to be more susceptible to febrile maladies than the natives. Certainly the natives of India do not appear to enjoy any immunity from fever. "It is," says Sir Clements Markham, "by far the most prolific cause of death, carrying off . . . very many more than all other disease and accidents put together" (except cholera). I cannot but be impressed with the fact, because it was to combat this state of things that the Government of India introduced Cinchona cultivation, by far the most important enterprise in which Kew ever took part.

It appears to me that the relation of a stationary population to local febrile diseases is governed by natural selection, and has possibly nothing to do with epidermal pigment. The more susceptible die off, the more immune survive. Variation in the phagocytes would do the whole business. In this way disease and population reach an equilibrium. In some cases a disease actually attenuates, to recover its virulence when, as in the case of measles in Fiji, it reaches new ground. At any rate, I think Wells's theory can hardly be accepted as a scientific fact. But it does not follow that epidermal pigment is useless because one explanation of it seems to fail.

I must add a few words about specific differences. Some one has recently observed that Mr. Darwin has given no definition of a species. I do not propose to attempt the task. But the majority of botanists demand that a "good species" shall be distinctly marked off from every other by definite and tangible characters. The members of the group may either conform pretty closely to a common type, or exhibit a good deal of variation amongst themselves, and this variation may be sometimes indifferent, sometimes adaptive. Such a variable group is generally considered to contain species "on the make"; but the indifferent variation will be remorselessly, if slowly, brought to book by natural selection. A botanical species is then a discontinuous group marked off by characters which I believe to be adaptive.

I have a strong suspicion that zoologists have a different conception of a species from that of botanists. I once heard Prof. Huxley say roundly, at a meeting of the Linnean Society, that there were no such things as species at all. The subject under discussion was a group of *Salmonidæ*, and he said that if the forms were arranged in a row, it was a purely arbitrary matter how any one chose to cut it up into species. But the same state of things might be paralleled amongst plants—as, for example, in *Hieracium*. The occurrence of such cases is not incompatible with the fact that the majority of species probably admit of being sharply defined, and are, in other words, discontinuous. This is, at any rate, the case with plants, and I do not see why it should not be equally so with animals. If, however, zoologists cut their species finer, it is intelligible that they may find difficulty in recognising the distinctive characters as adaptive. Prof. Poulton, in the discussion at the Linnean Society, went the length of saying that he saw no objection to giving a name to every distinct form, leaving it to be afterwards decided if it were or were not entitled to specific rank. Such a proceeding, if general, would throw taxonomy into a state of chaos. It has been adopted by a few botanists; but by common consent their writings, though not without a certain interest as studies in variation, have been excluded from serious taxonomic literature.

W. T. THISELTON-DYER.

Kew, July 20.

IN his letter, published in NATURE of July 16, Prof. Lankester has formulated with great clearness his views concerning the utility of specific characters; and he explains that his chief object in doing so is to draw attention to certain statements of mine, which he declares to involve a serious logical fallacy. While I am grateful for the courtesy with which Prof. Lankester has tempered his condemnation of my logic, I am still unconvinced; and the point at issue is so important that I am anxious to state, as clearly as I can, what my own position is. I may perhaps conveniently begin by quoting in full a passage from a former paper. Last year I wrote as follows:

"In order to estimate the effect of small variations upon the chance of survival, in a given species, it is necessary to measure *first*, the percentage of young animals exhibiting this variation; *secondly*, the percentage of adults in which it is present. If the percentage of adults exhibiting the variation is less than the percentage of young, then a certain percentage of young animals has either lost the character during growth, or has been destroyed. The law of growth having been ascertained, the rate of destruction may be measured; and in this way an estimate of the advantage or disadvantage of a variation may be obtained" (*Roy. Soc. Proc.*, vol. lvii. p. 381).

Prof. Lankester objects to this passage; and, if I understand him rightly, his objection may be stated in this way:—Admitting it to be proved that variation in a certain dimension, among young animals of a species, is associated with change in the death-rate, so that when this dimension increases the death-rate increases, and when it diminishes the death-rate diminishes; so that by ascertaining the magnitude of this dimension in a young animal you can accurately measure its chance of becoming adult; —admitting this relation to hold through a range of experience sufficient to form the basis of a reasonable induction, you have still no right to say that change in the observed dimension is a cause of the subsequent change in death-rate: for the two observed phenomena, namely the change in the observed dimension and the subsequent change in the death-rate, may alike be due to variation in some unobserved character, which alone is effective in causing change of death-rate.

In other words, you have a phenomenon, namely death-rate, preceded invariably by two or more phenomena of structure or function; and these are so associated, that from a known change in the antecedent group of phenomena, affecting always every member of the group, you can infer a change of known magnitude in the death-rate. Under these circumstances, Prof. Lankester thinks it legitimate to pick out one of these antecedent phenomena, and to speak of it as the only effective cause of change in death-rate, the other changes, although equally universal, being merely unimportant concomitants of this one essential change. He further finds something extraordinary in my logical position when I disagree with him, and considers every member of the group of correlated changes which invariably precedes change in death-rate as one of the causes of that change.

I have ventured to restate Prof. Lankester's position in my own words, in order to show what I believe him to mean. If I have in any way misrepresented him, I trust he will forgive me.

My own view seems to me identical with that held by a large number of persons, from Hume onwards; and for that reason I hope Prof. Lankester will not think I am indulging in an "empty wrangle" if I ask whether he accepts the following statement:

"We may define a cause to be *an object, followed by another, and where all the objects, similar to the first, are followed by objects similar to the second*, or in other words, where, *if the first object had not been, the second never had existed*. . . . We may . . . suitably to experience, form another definition of cause, and call it, *an object, followed by another, and whose appearance always conveys the thought to that other*. But though both these definitions be drawn from circumstances foreign to the cause, we cannot remedy this inconvenience, nor attain any more perfect definition, which may point out that circumstance in the cause, which gives it a connection with the effect. We have no idea of this connection; nor even any distinct notion of what it is we desire to know, when we endeavour at a conception of it" (Hume: "Inquiry concerning Human Understanding," § vii.).

When I have spoken of cause and effect, I have always endeavoured to use the words in accordance with the definition given in this passage or in Kant's extension of it; but Prof. Lankester seems to go beyond it. At least, the process of selecting one out of a group of universal antecedents, and calling that one alone the effective cause of the consequent, seems to me to involve precisely that knowledge which Hume and all his followers disclaim. For unless he knows "that circumstance in the cause which gives it a connection with the effect," how does Prof. Lankester pick out that one of the universal antecedents of an event which he chooses to call the cause? Such selection would have been impossible to Hume; and if Mill had regarded it as possible, he would hardly have defined a cause as "the sum total of the conditions, positive and negative taken together; the whole of the contingencies of every description, which being realised, the consequent immediately follows."

It is the assumption of the right to choose one out of a number of universal antecedents, and to regard this as the only cause of the consequent, which I have ventured to call illogical: and since Prof. Lankester has quoted Mill against me, I would ask him to read Mill's opinion of such a proceeding.

The prevalence of this practice in biological speculation tends more than any other habit to that neglect of the real complexity of the phenomena of life which Prof. Lankester himself so justly deprecates. For example, the contraction of the body of an amœba has been discussed of late years in two ways. Observers, following Prof. Lankester's method, have discussed the question, how much of the body of an amœba is the effective cause of its contractility? It is possible roughly to divide the body of an amœba (neglecting the nucleus) into an apparently more solid net-work or sponge-work, and an apparently more fluid substance in the meshes of this sponge-work. The question has been hotly debated, which of these two substances should be regarded as the essentially contractile element, the other being an unimportant concomitant. Each alternative has had its advocates, and neither party has convinced the other. Readers of NATURE are aware that a short time ago Prof. Bütschli attacked this question from the standpoint which I am here advocating: that is to say, he regarded each of the substances, invariably antecedent to contraction, as one of the causes of the contraction. By considering the changes in the relation between the two, Prof. Bütschli was at least enabled to make a dead

model which imitates with remarkable exactness the phenomena of amœboid movement; while the suggestion that such movement falls into the same category as the change in surface-tension at the boundary between two not-living liquids with change in the constitution of either, is a most important step in the "explanation" of contractility in general.

Here then is a phenomenon which had for years been rendered more obscure by the attempt to fix upon one of its two universal antecedents as its effective "cause"; while some kind of explanation was at once forthcoming when both antecedents were taken into account. It would be easy to multiply examples of this kind; but perhaps the foregoing may suffice.

I would only now reiterate my hope that in trying to make plain my own position I have not in any way misrepresented that adopted by Prof. Lankester. W. F. R. WELDON.

Marine Biological Laboratory, Plymouth, July 18.

IT appears to me that Prof. Weldon's argument, referred to in NATURE of July 16 (p. 245), is accurately represented in the following illustration. It might be an established fact, although it is not in reality, that there was a constant correlation between baldness and short-sightedness. Suppose that it were so, and that in a country where conscription was enforced, short-sighted men were exempt from military service: that is to say, let us suppose that a test was applied to the eyes of all men at a certain age, and that those whose vision was not normal were rejected and allowed to return to the peaceful pursuits of civilian life. These rejected men would, on the hypothesis, be all more or less bald, and according to Prof. Weldon's position, it would be quite as correct to say that they were not in the army because they were bald, as to say they were rejected on account of myopia. Now it is quite true that the officers of the army medical staff might save themselves trouble by rejecting all bald-headed men, because, on the hypothesis, all such men would be short-sighted; but it would be obviously wrong to conclude that a good development of hair was essential to military efficiency.

Prof. Weldon argues that it is enough to prove that individuals of a species are selected according to a certain character, and that it is unnecessary to discover whether survival depends directly on this character, or on some other with which it is correlated. He seems to have concentrated his attention on the attempt to demonstrate directly the occurrence in nature of individual selection, in this peculiar sense, and to be temporarily indifferent to all other questions.

Prof. Lankester suggests that specific characters would be explained if it were proved that they were correlated with adaptive characters. It is of course perfectly true that if there were such constant correlations, then the survival of adaptive variations would involve also the survival of the indifferent characters connected with them. But the difficulty is to prove that in many cases there are *any* important differences of adaptation between allied species. It is easy enough to define the specific differences and specific characters; but to find any differences which correspond to differences in the mode of life, is often exceedingly difficult. It is true we find in most cases some differences in the conditions of life of closely allied species, but we do not usually find peculiarities of structure which can be said to be adapted to those differences. Who, for instance, can say what adaptation is present in the pilchard or sprat differentiating either from the other or from the herring? The question, therefore, is not whether indifferent specific characters are correlated with useful characters, but whether species of a single genus are distinguished from one another by any characters which can be proved to be useful or adaptive. The tongue and hyoid of the woodpeckers are beautiful adaptations; but are there any differences of selection value between one species of woodpecker and another? The denial of the utility of specific characters means, not merely that some specific characters are indifferent while others are adaptive, but that adaptations are not in the great majority of cases distinctive of species at all. Therefore, as the late Mr. Romanes often ably demonstrated, natural selection is not a theory of the origin of species, but only a theory of the origin of adaptations. The further objection, that a theory of selection is only of secondary importance in comparison with a theory of the origin of variations, I will not enter upon on this occasion. J. T. CUNNINGHAM.

College of Surgeons, July 17.

The Position of Science at Oxford.

WILL you allow me a few lines in which to express my entire agreement with your recent article on this subject, if only to emphasise the fact that I am not the author of the article, and that the opinions there expressed are not those of an isolated individual. The reason for the comparative neglect of natural science at Oxford is that, however well-disposed some individuals may be, the college tutors and lecturers as a rule dislike it. They dislike it for two reasons. First, because it cannot be taught in the college parlours called lecture-rooms; and second, because they are, as a rule, ignorant—owing to their own defective education—of the nature and scope of the immense field of study comprised under the head "natural science." They do not know either the enormous educational value of natural science, or its vital importance to our national life and development.

And lastly, if they did know, there is no conceivable motive which could operate so as to induce them to sacrifice some of the rewards and educational domination, which are at present enjoyed by the long-established classical and historical studies, to newer lines of work in which the present beneficiaries and their academic offspring can have no share.

The situation is a "dead-lock," and only an intelligent Parliamentary Commission (if such is possible) can put matters on to a fair and healthy basis Probably the scandal of the present paralysis of our beloved Oxford will have to become even greater and more outrageous than it is at this moment, before the necessary remedy is applied.

But happily the vitality of Oxford is indestructible. The misused and monopolised resources of Oxford will assuredly some day be devoted to the true purposes of a great University.

E. RAY LANKESTER, Linacre Professor, Oxford.

THERE are some points in the article on this subject in NATURE of July 9, which call for comment. The defects pointed out are not, I believe, due to the causes mentioned by your correspondent. The fault lies mainly in the public schools. The lower forms of public schools are, as a rule, mainly classical, the division into sides, classical, modern and science, only beginning when a boy has finished about half his school career. The choice of sides is chiefly left by the parents to the masters, and since in the lower forms these masters have, as a rule, little sympathy with any kind of work which is not purely classical, boys of ability are drafted as a matter of course into the classical side. The boys who enter the science side are often the failures of the classical side, and unless special care is taken by the science masters, even they are kept at classics until it is hopeless to make them into respectable science scholars. Naturally there are many exceptions; some clever boys have enlightened parents, and others, early developing a taste for scientific matters, persuade their parents to allow them to give up the dead languages. There are also some classical men who admit that other subjects than their own have educational value. But the rule is for the able boy to be kept at classics, while his less favoured brother is sent to science. I know that this is the case at the five public schools with whose working I am familiar, and I have little doubt that the science masters of other public schools have the same experience. Occasionally able boys are recruited from the modern side, and it is these boys who are practically shut out from Oxford. However small the knowledge of Greek required for passing responsions may seem to a classical man, it is no light matter for a boy who has it all to learn in little more than a year, and who has much other work to do during the time. At Cambridge the necessary knowledge of Greek is almost nominal, and it is a pity it is not abolished altogether. If both Universities would substitute a good knowledge of German—so necessary for every scientific student—for the very imperfect and quite useless modicum of Greek which they now require, it would result in a great saving of time to many science students, and ultimately in raising the science standard at both Universities.

H. B. BAKER.

IN your article on "Science at Oxford," in NATURE for July 9, you say: "It may be objected that every public school has one or more science masters of tried capacity, and that science is a compulsory subject in nearly all."

The first part of this statement may be correct, but I venture to demur to the second. Certainly at one school I could name,

where over £10,000 has been spent on scientific equipment, science is not a compulsory subject; and, in fact, it is practically impossible to get science teaching on the classical side.

It would be interesting to know how far science is compulsory in the various public schools. I have no doubt there are others, but I only know of two—Eton and Clifton—where it is.

"A Parent."

Discharge of an Electrified Body by Means of the Tesla Spark.

It has been shown that a body charged with electricity may be discharged by means of the rays from a Röntgen bulb. I find, also, that an electrified body is rapidly discharged by the influence of a high-frequency spark, such as that produced by the Tesla apparatus. The discharging action was shown in this way. A high-frequency spark was produced between two rather blunt points, one inch apart in air, no bulb being used. A gold-leaf electroscope, placed far away from the influence of the spark, was used to test the electrical condition of the charged bodies—viz. a stick of sealing-wax and a rod of glass. The sealing-wax was rubbed, and the electroscope indicated that it was well charged. It was again rubbed, and then brought to within a foot of the points, and by means of a key in the battery circuit the Tesla coil was thrown into action for an instant. On testing the sealing-wax rod with the electroscope, it was found to be entirely discharged. A similar experiment was next made with a glass rod; the glass rod was entirely discharged by the Tesla spark. From a previous experiment, it was seen that the electrification of the rods was dissimilar. The influence, then, of the high-frequency spark is to discharge electricity of either sign.

Frederick J. Smith.

Oxford, July 17.

On the Occurrence of the Pelagic Ova of the Anchovy off Lytham.

Hitherto no free eggs of this species have been procured in Britain, though Mr. Jackson found ripe females off Southport in June 1878. Day observes, in the "Brit. Fishes," that the anchovy spawn off our coasts in September and December; though in June specimens have been found with enlarged ova, and so tender that they burst on the slightest interference. On June 26 last, however, Mr. R. L. Ascroft, of Lytham, obtained certain ova in the tow-nets used off Lytham Pier, which he courteously sent for examination in a solution of formalin. These eggs agree in all respects with the descriptions and figures of Hoffman, Wenckebach, and Raffaele, though somewhat larger.

Prof. Hoffman found that the anchovies of the Zuyder Zee were ripe in the months of June and July, and that the eggs were of an oval form, and about 1 mm. in length. In July 1886, Wenckebach captured the same eggs in his tow-nets, and hatched them on the third day. The egg is ovoid, and the yolk reticulated as in other clupeoids, such as the sprat. Raffaele procured the same egg at Naples—from May to September—and also ascertained that hatching took place after two or three days. He gives the long diameter of the egg as 1·15 to 1·25 mm., and the shorter at 0·5 to 0·55 mm. The larva is provided with a reticulated yolk of little depth, but of great length, extending, indeed, considerably beyond the middle of the body, while the notochord is unicolumnar. In two or three days after hatching the yolk had greatly diminished, the pre-anal fin-membrane was augmented, and the dorsal had likewise passed much further forward. The buccal aperture had also opened, and four branchial arches were visible. The yolk had completely disappeared about the fourth or the fifth day, and pigment occurred in the eye and along the dorsum. The post-pyloric portion of the gut was transversely ridged.

The eggs sent by Mr. Ascroft were, for the most part, advanced; the embryo occupying the long axis of the egg, as usual in such cases, and as shown by Raffaele. The long diameter ranged from 1·295 to 1·447 mm., the shorter diameter being almost constant at 0·685 mm.; they are thus larger than those from the Mediterranean and the Zuyder Zee.

Interesting accounts of the occurrence of anchovies off the British shores have been given by Prof. Ewart and Mr. Cunningham, and they would seem to be by no means so rare as at one time supposed. Prof. Hoffman thought that very rapid growth occurred during the first year of the life of the anchovy, so that those spawned in June and July reached a length of 12 cm. at the end of October, and Dr. Hoek appeared to agree with him. Ehrenbaum, however, asserts that the young anchovies referred to are in their second year; and this would be more in harmony with what is known of the herring, the pilchard, and the sprat. This author considered that the anchovy breeds when two years old.

W. C. M.

Gatty Marine Laboratory, St. Andrews, July 16.

Information on Scientific Questions.

Dr. Brown Goode is quoted in Nature of July 16 (p. 252), as saying "he cannot think of any scientific subject regarding which a letter, if addressed to the scientific bureaus in Washington, would not receive a full and practical reply." I infer from this that the replies are prompted by the courtesy of the officers of the various departments, and that the public of the United States possess no right to demand them. If this is so, surely Dr. Brown Goode's scoff at British Government departments is disingenuous, to say the least of it.

But though we have no *right* to apply for information to Government departments, it must have been the experience of great numbers of people that information may be most readily obtained, and that only very exceptionally does a public officer fail to reply to any reasonable inquiry relating to his own branch of science—or art. I have myself made frequent inquiry of officers of the British Museum, both at Bloomsbury and South Kensington, and in every case (save one) have had courteous and satisfactory replies from those to whom my inquiries were addressed. I have received similar treatment from the Department of Science and Art, from the Society of Antiquaries, from the Board of Trade, from the Agricultural Department, from the Royal Academy, from the School of Mines, and from other bodies which, though in this country they are of a pseudo-private character, would in the States probably come under some public department.

It may be that the experience of others has been less favourable than mine; but this I find it difficult to believe, and unless Dr. Brown Goode means us to understand that the Washington bureaus may be peremptorily applied to for information, it would be seemly to withdraw the implied charge of discourtesy which he has levelled at our public officers.

I would further point out that in many of our country towns and cities there exist municipal museums, to which local inquiries are first addressed, whence information may be obtained, at, I confess, considerable inconvenience to the curators. I have myself had inquiries on all sorts of questions from agriculturists, medical men, colonists, genealogists, artificers, tradesmen, youthful collectors, and the general public, some of which have taken me two or three hours, and occasionally a microscopic examination of specimens, to solve, and doubtless many other persons could tell of similar experiences. It is quite remarkable how entirely the public have adopted the view that a curator of a museum is a fit and proper person to consult upon any and every subject; but my experience leads me to think that curators have brought this condition of things upon themselves.

Exeter, July 20.

James Dallas.

Horary Variation of Meteors.

Dr. Doberck, of whose paper an interesting abstract was given on June 25, informs us that shooting-stars decrease in average magnitude from evening to morning, their duration and length of path decreasing with the magnitude, while the velocity increases as the magnitude diminishes.

This larger evening magnitude is said to be "owing to the fact that the meteorites are heated to incandescence nearer the earth in the evening than in the morning," a fact deserving further explanation.

In the morning we stand on the front of the earth in her orbital motion; the earth then generally meets the meteors with the double velocity of their two motions. In the evening the meteors are overtaking the earth with a slower motion, the difference of their velocities. In the morning, therefore, the meteors enter the atmosphere with double velocity, and are burned up before nearly reaching the earth. In the evening, the slower motion enables them to penetrate further through the atmosphere before becoming incandescent.

So also most aerolites fall in the evening hours, although shooting-stars are most numerous in the morning.

The impalpable air shields the earth from those meteorites whose impact would be dangerous, burning them up by their very velocity, while giving passage to those whose slower motion renders them comparatively harmless.

G. C. Bompas.

London, July 18.

AUGUST KEKULÉ.

BY the death of this eminent chemist at the age of sixty-six, which took place on July 13, science loses one of her most distinguished votaries. It is only four years ago since a remarkable demonstration was held in Bonn in celebration of the twenty-fifth year of Kekulé's professorship in that University. Two years previously, in March 1890, a similar rejoicing had been held in Berlin in honour of the twenty-fifth anniversary of the promulgation of the benzene theory by its illustrious author. It appears that Kekulé was intended by his father to have been an architect, and for that purpose he was sent to Giessen to become proficient in the subject after having undergone a preliminary training of the ordinary kind at the Darmstadt Gymnasium. At Giessen he came under the powerful spell of Liebig, and having attended some lectures on chemistry by that great master, his inclination towards the adoption of this science as a profession instead of architecture appears to have received a strong impulse. After a short period of probation at the Darmstadt Polytechnicum, where he tells us he learnt chemistry under Moldenhauer, and spent his leisure in lathe-turning and modelling in plaster, he returned to Giessen and entered as a student under Liebig and Will. Even at this stage of his career he appears to have been capable of rendering material assistance to his master in the experimental work being carried on in connection with the familiar "Letters on Chemistry," in which Liebig includes the name of Kekulé among those of many other chemists now well known in science, in acknowledgment of the services rendered by the future founder of structural organic chemistry. That Liebig thought highly of his pupil may be inferred from the circumstance that he very nearly received the appointment of assistant in the Giessen laboratory, then renowned throughout Europe for the chemical work being carried on there. Instead of remaining at Giessen, however, young Kekulé went to Paris, and having sat at the feet of Regnault, Frémy and Wurtz, he was casually attracted by a course of lectures on chemical philosophy advertised by Gerhardt, who had resigned his professorship at Montpellier, and was giving private courses of instruction in the French capital. Gerhardt appears also to have recognised the capabilities of his student, and an intimate personal friendship sprang up between them. It is probable that this contact with Gerhardt acted as a stimulus in developing the particular faculty as a theoriser which must have been inherent in Kekulé, and which found expression in all his later work. From Paris, where he declined an invitation to become Gerhardt's assistant, he went for a short time to Switzerland as assistant to Von Plantu in the Castle of Reichenau. After this Swiss sojourn, and chiefly at the instigation of Bunsen, he accepted an offer from the late Dr. Stenhouse, then at St. Bartholomew's Hospital, and for a time this country had the honour of fostering young Kekulé. The bent of his mind in the direction of chemical theory is well brought out by his confession in later life that he did not derive much profit from his experience at St. Bartholomew's; but having become acquainted with Williamson, who had just completed his classical work on etherification, he appears to have found a more congenial outlet for his energies in the school of thought being evolved by that investigator and Odling, and which he declared, in 1892, to have been an excellent school "for the encouragement of independent thought." While in this country an offer was made to Kekulé that he should remain here as a technologist, but the Fatherland had greater attractions for him; his great ambition was to become attached to a German University, and he started a small laboratory in the house of a corn merchant in the main street of Heidelberg, where he received pupils. In these days of palatial laboratories, it is interesting to recall that in this little kitchen Kekulé carried out his work on the fulminates, and that Baeyer, then one of his pupils, conducted his researches on cacodyl. It is not the laboratory that makes the chemist!

Kekulé's first call as ordinary professor was to Ghent, where the Belgian Prime Minister was instrumental in getting him a modest laboratory; and here for nine years he worked with a success that can be measured by the fact that, in addition to Baeyer, he numbered among his pupils Ladenburg, Victor Meyer, Wichelhaus, and others whose names are as household words in the annals of chemical science. From Ghent he was "called" to Bonn, in which University the magnificent laboratories grew under his inspiring influence, and where he remained till the last, adding to the lustre of his reputation and shedding the light of his intellect over that country in which modern chemistry appears to have found its head-quarters.

As an experimentalist, Kekulé's contributions to science are not great as compared with the enormous influence which his genius for theorising has exerted upon the development of the science of the century. His greatest and most precious gift was his power of penetrating into the inner mysteries of molecular constitution, and it is through this work that his name will ever be revered. It was Kekulé who first gave definite form to Frankland's conception of valency, and his application of this idea to the study of the carbon compounds was nothing less than epoch-making. Out of this conception grew the famous theory of cyclic compounds, which has been prolific to an extent almost unparalleled in the history of pure science, and which from the practical side has made Germany what it is in the domain of organic chemical technology. If the life-work of any chemist of our age need be quoted as a standing protest against the *cui bono* attitude of mind which we in this country are still suffering under, and which relegates abstract theoretical studies to the realms of "academic" thought remote from human interests, let the speculations of August Kekulé be put forward as an answer crushing and complete for all time.

The present writer never had the privilege of coming into personal contact with the master-thinker who has so recently passed away. His geniality of disposition appears to have endeared him to all who came under his influence. The chemists of this country join with those of the Fatherland in mourning over the gap that has been caused in their ranks.

R. M.

NOTES.

THE International Geological Congress will hold its seventh session at St. Petersburg at the end of August next year, under the acting presidency of Dr. A. Karpinsky, and with the Grand Duke Constantine as honorary president. The session will continue about a week, and the proceedings of the Congress will not be divided into sections, as at Zürich, but will be devoted chiefly to the discussion of broad principles. Extended excursions are announced, the most important being to the Ural Mountains before, and to the Caucasus after, the meeting at St. Petersburg. Shorter excursions have also been arranged to Finland and elsewhere. Geologists who propose to attend this meeting should send notice of the excursions in which they wish to participate, before next October, to the General Secretary of the Congress. The Emperor of Russia has decided, on the favourable report of the Minister of Public Ways, to grant to all geologists duly enrolled for the meeting, free first-class railway tickets during their sojourn in Russia.

THE forty-second annual meeting of the German Geological Society will be held at Stuttgart, on August 9–12. Another important annual meeting is that of the German Anthropological Society, which takes place on August 3–6, at Spires.

THE Royal Institution of Science, Letters, and Arts of Venice offers a prize of 3000 lire for the best essay on the alluvial matter brought down from the Alps by one of the principal rivers of Venetia. The competition remains open till December 31, 1896.

AN effort is to be made to induce the Prince of Wales to place himself at the head of the movement for celebrating at Bristol, in June next year, the 400th anniversary of the discovery of North America by John and Sebastian Cabot, who sailed from Bristol. It is hoped that the foundation-stone of the memorial will be laid by the Prince of Wales simultaneously with one laid in Canada.

THE International Congress of Applied Chemistry was opened in Paris on Monday. Sixteen hundred delegates were present, of whom six hundred were from other countries. M. Berthelot, Perpetual Secretary of the Academy of Sciences, was elected President of the Congress, and delivered a powerful inaugural address, in the course of which he dwelt particularly on the relation between pure and applied science, the remarkable results obtained by the alliance of physics and chemistry, and the beneficent part that science has played in the history of the past three-quarters of a century.

THE Russian Geographical Society has awarded this year its Constantine medal to M. A. Rykacheff, for his work in the domain of physical geography. Beginning in the year 1874 with a work on the distribution of atmospheric pressure in Russia, he continued to publish a series of researches on the diurnal variations of pressure, the prevailing winds of the Caspian and the White Seas, the tides in the atmosphere, the freezing and thawing of the Russian rivers, the variations of the levels of rivers in Middle Russia, in connection with variations in the amounts of rain and snow, the diurnal variations of temperature over the tropical oceans, &c. A full list of M. A. Rykacheff's works, mostly written in German and French, is given in the yearly Report of the Society. The Count Lütke medal has been awarded to Admiral Makaroff, for his work on the temperature and density of water in the Northern Pacific, based on the measurements made in 1886–89 on board the *Vityaz*. His maps of the distribution of surface temperature in August, and of temperature at a depth of 400 metres, are especially worthy of notice. The Prjevalsky prize was awarded to M. Berezovsky, for his explorations of the northern borderlands of Tibet. A Prjevalsky medal was awarded to J. A. Schmidt, for his twelve geodetical expeditions to different parts of Central Asia and Siberia; and one to Dr. H. A. Fritsche, for his magnetic measurements in China, Mongolia, Siberia, and Russia. Two small gold medals were awarded to F. F. Müller, for his magnetical work in East Siberia; and to A. A. Lebedintseff, for his researches into the chemical composition of water in the Black and Azov Seas. Eighteen silver medals were awarded for various works of lesser importance.

A FULL description of the cell invented by Dr. W. W. Jacques, for the production of electricity by the consumption of carbon, is given in the July number of the *Engineering Magazine*, by Mr. G. H. Stockbridge. The apparatus consists of a pot of pure iron surrounded by a suitable furnace and containing caustic soda, in which hangs a rod or cylinder of carbon. The carbon must be in such a state that will serve as a good conductor of electricity. Gas, carbon, and charcoal are available without special treatment; but anthracite coal has to be baked to give it the requisite conductivity, and bituminous coal needs, for the same purpose, to have some of its hydrocarbons driven off. Commercial caustic soda can be used without expelling the usual impurities. Air is forced through the caustic soda by means of an air-pump. To set the cell in operation the furnace and its enclosed generator containing the caustic soda is brought to a temperature of 400° to 500° C., and the air-pump is put in action. The caustic soda takes up oxygen from the air, and releases it at the carbon. The carbon is attacked by the oxygen, and suffers a gradual consumption as long as the operation continues, an electric current being produced as a result of the action, the poles being the iron pot and the carbon rod. Some electricians say the current is only a thermo-electric one. The cell is said to have an efficiency of eighty-five or ninety per cent. This efficiency does not, however, take into account the expenditure of heat for maintaining the cell at a suitable temperature, or of the power used in running the air-pump which supplies it with oxygen. Dr. Jacques' cell is an interesting addition to the list of others devised to obtain electricity as a direct result of the consumption of carbon; but whether it will become of practical value, cannot yet be decided.

IT seems as if the Boltzmann-Maxwell distribution of the kinetic theory of gases is likely to become an everlasting bone of contention. A short time ago we chronicled in these columns an attack on Maxwell's original proof by M. Bertrand in the *Comptes rendus*, on the ground that the proof assumed independence of the frequencies of distribution of the velocity-components of a molecule of the gas resolved in three directions at right angles. This paper called forth a rejoinder from Prof. Boltzmann, inviting M. Bertrand to examine Maxwell's later proofs. M. Bertrand replied that he considered these even worse than the first. Dr. Carlo del Lungo, writing in the *Atti dei Lincei* in defence of the proof first objected to by M. Bertrand, now endeavours to prove that the assumed independence of distribution of velocities is a necessary consequence of the principles of conservation of momentum and of energy. It certainly seems impossible to give a rigorous proof of the Boltzmann-Maxwell distribution without making *some* assumption beyond the ordinary principles of pure dynamics (*e.g.* the assumption that the only intermolecular forces are those due to impact). But Dr. del Lungo also upholds the view that the general evidence in favour of the law lies in the fact that the distribution in question satisfies so many conditions which are not satisfied by any other distribution, and which represent more or less closely the phenomena present in gases.

DR. A. LAMPA, working in the laboratory of Prof. Franz Exner, has determined the refractive indices of a number of substances for electric waves of very small length. The experiments, which form the subject of a communication to the *Wiener Sitzungsberichte*, were made with electromagnetic radiations of 8 mm. wave-length; this number being ascertained both from the dimensions of the excitor and by diffraction observations. The wave-length in question corresponds to the frequency $N = 37{\cdot}500 \times 10^6$, and Dr. Lampa gives the following values for the index n: Paraffin, 1·524; ebonite, 1·739; crown glass, 2·381; flint glass, 2·899; sulphur, 1·802; benzole, 1·767; glycerine, 1·843; oil of turpentine, 1·782; oil of vaseline, 1·626; oil of almonds, 1·734; absolute alcohol, 2·568; and distilled water, 8·972.

M. L.-A. MARMIER, of the Pasteur Institution, has communicated to the Société Française de Physique the results of an interesting series of experiments on the action of currents of high frequency on microbian poisons. It had been previously announced by MM. d'Arsonval and Charrin that such currents affect these poisons to a considerable extent, and M. Marmier has examined whether this modification is a new phenomenon, or merely a secondary result of well-known effects of the current. It is found that the alteration in question only occurs when the liquids are allowed to become heated to a temperature which would alone suffice to modify the poisons. When

the liquids are kept cool by suitable precautions, no modification takes place, and M. Marmier concludes that currents of high frequency do not themselves affect microbian poisons. The experiments were performed on the toxin of diphtheria, that of tetanus, and the venom of the cobra snake.

IN the June number of the *Annalen der Hydrographie* there is an interesting discussion, by H. Haltermann, of the occurrence of St. Elmo's Fire at sea, based upon observations in the log-books received at the Deutsche Seewarte. The tables contain full details as to position, conditions of weather, &c. During more than 77,000 days of observation, the phenomenon was observed 164 times, 87 times in north, and 77 times in south latitude. Its occurrence differs very considerably in different parts of the ocean, *e.g.* in the ten-degree square lying between the equator and 10° N. lat., and between 20° and 30° W. long., St. Elmo's Fire was observed about three times per 1000 days, while in the two squares lying between 50° and 60° S. lat. and 60° and 80° W. long. it occurred six times per 1000 days. The more frequent occurrence at sea than on land is attributed to the fact that the accumulating electricity is more easily conducted by the numerous objects projecting into the air over the land.

ON July 2, Prof. Wiesner presented to the Vienna Academy of Sciences an investigation on the important relation of plant-life to photo-chemical climate, based on observations made at Vienna, Buitenzorg (Java), and Cairo. The measurements of the chemical intensity of light were made by a process corresponding in principle to the photographic method of Bunsen and Roscoe. The following are the principal results arrived at: (1) The greatest chemical intensity of light at Vienna amounted (in Bunsen-Roscoe units) to 1·500, and at Buitenzorg to 1·612. (2) The average ratio of the noon intensity to the daily maximum at Vienna was as 1 : 1·08, and at Buitenzorg as 1 : 1·22. (3) At Vienna the yearly noon intensity varied in the proportion of 1 : 214, and at Buitenzorg, in the proportion of 1 : 124. (4) As a rule the daily maximum at Vienna occurred about noon, and at Buitenzorg in the late forenoon. This explains the relatively high maxima at Vienna, and the relatively low maxima of Buitenzorg. In clear or uniformly cloudy weather, the maximum occurred generally at noon at both places. (5) At Cairo a strong depression of the daily curve of intensity was observed at noon, during a perfectly clear sky. This depression was also observed on rare occasions at Vienna, but to a smaller extent. (6) At Buitenzorg the chemical intensity of light was generally greater in the forenoon than in the afternoon. At Vienna this excess was greatest in June and July; the morning intensities were generally higher than the corresponding evening intensities, even when the sky was similarly clouded.

GENERAL PYEVTSOFF, who has had great experience in the measurement of altitudes in Central Asia with the barometer, publishes in the *Memoirs* of the Russian Geographical Society a very valuable paper on barometrical levellings, in which he points out once more the degree of precision that can be obtained from such measurements. He discusses separately the errors in the calculated altitudes which are due to disturbances in the atmosphere resulting from cyclonic and anticyclonic air-movements, to the error in the determination of the average temperature of the air between the two stations at which the barometer has been simultaneously observed, &c., and he gives their relative importance under different circumstances. The most valuable part of the author's inquiry is the comparison which he has made between the real differences of altitudes of twenty-eight different meteorological stations, situated at distances of from 67 to 270 miles from each other, and the altitudes which are obtained day by day from a comparison of the readings of the barometer at the stations, taken in pairs. It appears, as a rule, that if the readings on the days of great atmospheric disturbances are not taken into account, the results are most satisfactory, and that the errors, due to an unequal distribution of pressure at the two stations, seldom exceed 100 feet, and only occasionally attain 140 feet, even for stations taken so wide apart as 100 and 270 miles. As to the altitudes determined in Central Asia, they very seldom exhibit errors exceeding 300 to 400 feet, which evidently is, for separate places, a quite sufficient approximation. At the end of his memoir, General Pyevtsoff gives new tables, based on Babinet's formula, for the calculation of altitudes without the aid of logarithms, which tables combine great accuracy with rapidity, and are very practically arranged.

THE extension of the use of pure yeasts has not unnaturally caused a good deal of attention to be of late bestowed upon the most efficient methods, both for their successful preservation and transmission. Pure yeast cultures can be purchased much as any other article of commerce at the present day, but a great deal depends upon how these so-called stock yeasts can be stored. Experience has shown that, in general, solutions of cane-sugar answer far better for this purpose than wort-gelatine or infusions of wort. In saccharine solutions, yeasts have been preserved in perfect condition for as long as fourteen years. There are, however, exceptions to this rule, for Hansen reports that the *Saccharomyces Ludwigii* dies off in from two to three years when kept in saccharine solutions; whilst Dr. Holm has quite recently described a particular variety of yeast obtained from some Jamaica molasses, which could not be persuaded to exist beyond twelve months in such solutions, whilst in wort-infusions it was still alive after the lapse of two and a half years. With these exceptions, however, saccharine solutions answer the purpose perfectly; but it is of great importance that vessels containing these stock yeasts, whilst occupying very little space, should obviate as far as possible the evaporation of the contents. This evaporation has caused no little trouble in the past; but, thanks to an ingenious device of Jörgensen's, it appears to be happily overcome. The apparatus employed has been recently described by Dr. Holm, to whom the conduct of the experiments involved in determining this point were entrusted, and his paper appears in the *Centrablatt für Bakteriologie*, part ii. Not only may the special flasks described be used for liquids, but they have been found also of great service in preserving gelatine cultures from drying up, and Dr. Holm tells us that, even six months after its preparation, the gelatine in these flasks still retained its soft consistency, and was not in this respect distinguishable from freshly prepared gelatine. This should overcome a difficulty with which bacteriologists are frequently troubled.

IN the summer of 1893, two of von Rebeur-Paschwitz's horizontal pendulums were erected at the observatory of Charkow, and the reports on the observations made with them are being issued by Prof. G. Lewitsky, now director of the Dorpat Observatory. The first pamphlet, consisting of sixty-three pages, is one of the most valuable contributions to the study of earthquake-pulsations so far published. It contains detailed records of 139 series of pulsations between August 4, 1893, and October 9, 1894, the time and amplitude of each marked phase being given, as well as the epochs of the beginning and end of the movement. The duration of some of the disturbances is extraordinary. Thus, the oscillations due to the Greek earthquakes of April 20 and 27, lasted for 14h. 50m. and 12h. 35m. respectively, and those from the Constantinople earthquake of July 10 for 13h. 26m. In these cases, however, the epicentre was not at a great distance. Turning to others of remoter origin, we find that the Japanese earthquake of March 22

affected the pendulum for 10h. 14m., and the Venezuelan earthquake of April 28 for as much as 10h. 30m.

WE notice in the Moscow geographical review, *Earth Knowledge* (*Zemlevedenie*), a very valuable paper, by M. Alboff, "On the Vegetation of West Caucasia." The paper is an introduction to his recently-published great work, "Prodromus Floræ Colchidæ."

THE Director of the Geodynamic Section of the Observatory of Athens has sent us the *Bulletin Mensuel Seismologique* for February, March, and April of the present year. The fact that these three numbers contain records of 147 earthquakes in Greece and the Ionian Islands, shows what an admirable field for study is placed before Dr. Papavasilion. Many of these shocks occurred in districts which have been recently visited by severe earthquakes, no less than sixty-six having been felt in Zante alone.

THE *Proceedings* of the Edinburgh Mathematical Society for the Session 1895–96 have just been published. Among the papers is one having an application to optical instruments, viz., "A summary of the theory of the refraction of thin approximately axial pencils through a series of media bounded by coaxial spherical surfaces, with application to a photographic triplet, &c.," by Prof. Chrystal. Prof. G. A. Gibson contributes to the volume an interesting descriptive review of Prof. Cantor's "Vorlesungen über Geschichte der Mathematik," with special reference to the rise of the infinitesimal calculus, and the Newton-Leibnitz controversy. There is also a paper on "The number and nature of the solutions of the Apollonian contact problem," by Mr. R. F. Muirhead, and others on "Symmedians of a triangle and their concomitant circles," by Dr. J. S. Mackay, and "On deducing the properties of the trigonometrical functions from their addition equations," by Mr. Muirhead.

FOUR parts of the *Transactions* of the Royal Society of Edinburgh, embracing the period 1893–95, are among recent publications. As we regularly print reports of papers read at the Edinburgh Royal Society, it is unnecessary to do more now than refer to a few of those published in the present parts of the *Transactions*. A paper, by Mr. Aitken, on dust particles, and the relation between them and meteorological phenomena, appears in part iii. of vol. xxxvii.; which also contains papers on the fossil flora of the South Wales coal-field, by Mr. R. Kidston, and on the variations of the amount of carbonic acid in the ground-air, by Dr. C. Hunter Stewart. The following part of the same volume has papers on the partition of a parallelepiped into tetrahedra, by Prof. Crum Brown; on the manganese oxides and manganese nodules in marine deposits, by Dr. John Murray and Mr. Robert Irvine; and on the chemical and bacteriological examination of soil, with special reference to the soil of graveyards, by Dr. J. Buchanan Young. The greater portion of part i. (vol. xxxviii.) is taken up with Dr. H. R. Mill's elaborate paper on the distribution of temperature in the Clyde Sea area. The paper is accompanied by thirty-two plates, most of them containing several coloured diagrams, and it is altogether a monument of painstaking observation and careful work. Among the remaining contents of the same publication are papers on bird and beast in ancient symbolism, by Prof. D'Arcy Wentworth Thompson, jun.; two glens (Glen Aray and Glen Shira), and the agency of glaciation, by the Duke of Argyll; and on the relation between the variation of resistance in bismuth in a steady magnetic field, and the rotatory or transverse effect, by Mr. J. C. Beatie. In part ii. of vol. xxxviii. are two extremely important papers, one on specific gravities and oceanic circulation, by Dr. Alex. Buchan; and the other on deep- and shallow-water marine fauna of the Kerguelen region of the great Southern Ocean, by Dr. John Murray. Dr. Buchan's paper is accompanied by nine maps, showing the specific gravity of the oceans at observed temperatures from the surface to a depth of 2000 fathoms. An immense amount of material has thus been brought together for the benefit of oceanographers.

AN important source of vanadium compounds has lately been discovered in South America. In the high plateaus of the Andes, at a height of about 16,000 feet, there exists a mine of anthracite containing vanadium. The coal from this mine, which is easily worked, burns easily, leaving about two per cent. of ash. This ash contains one-seventh to one-quarter of its weight of vanadium, besides some silver, with traces of zirconium and platinum. The extraction of the vanadium on the large scale has been accomplished by M. K. Hélouis, who has applied it to the preparation of aniline black, to the colouring of porcelain, and in metallurgy. The vanadium used by M. Moissan in the preparation of vanadium carbide came from this source.

IN the current number of the *Berichte* there is an account, by Mr. O. Piloty, of a new method of preparing the salts of hyponitrous acid, for which it is claimed that the yield is in advance of all methods previously described. Hydroxylamine hydrochloride, by treatment in alcoholic solution with sodium ethylate and benzene-sulphonic chloride, is converted into benzene sulphonehydroxylamine, $C_6H_5.SO_2.NH.OH$, and this, on treatment with concentrated potash solution, gives the potassium salts of benzene-sulphonic and hyponitrous acids, which can be separated without difficulty. The mechanism of the reaction is precisely analogous to the production of hyponitrite from potassium hydroxylamine mono-sulphonate, discovered by Divers and Haga (*Jour. Chem. Soc.*, 1889, p. 760). In a subsequent note, referring to the preliminary note by Hantzch, stating that anhydrous hyponitrous acid can be obtained, Mr. Piloty describes the results obtained by him in this direction. Silver hyponitrite, suspended in ether and treated with hydrogen chloride, gives silver chloride and a solution of $H_2N_2O_2$ in ether. Rapid evaporation of the ether causes the deposition of the acid as an oil, which solidifies to a crystalline mass in a freezing mixture. As might be expected, both the oil and solid possess highly explosive properties. Of the numerous isomerides of the formula $H_2N_2O_2$ theoretically possible, this is the second to be isolated, the nitramide NH_2NO_2 of Thiele and Lachman being the first.

THE additions to the Zoological Society's Gardens during the past week include a Barbary Ape (*Macacus inuus*, ♀) from North Africa, presented by Mr. E. G. Walls; a Bonnet Monkey (*Macacus sinicus*, ♀) from India, presented by Mr. P. Clarke; two Macaque Monkeys (*Macacus cynomolgus*, ♂ ♀) from India, presented by Mrs. Williamson; an Ocelot (*Felis pardalis*) from Trinidad, presented by Mr. H. O. Nicholls; a Black-tailed Flower-Bird (*Anthornis melanura*) from New Zealand, presented by the Hon. Walter Rothschild; a New Zealand Parrakeet (*Cyanorhamphus novæ-zealandiæ*) from New Zealand, presented by Miss A. Malcolm; a Bare-eyed Cockatoo (*Cacatua gymnopis*) from South Australia, presented by Mrs. M. E. Huntley; a Boobook Owl (*Ninox boobook*) from Australia, presented by Dr. R. Broom; a Raven (*Corvus corax*), British, presented by Mr. William Soper; a Rook (*Corvus frugilegus*), British, presented by the Rev. A. Greaves; six Purplish Death Adders (*Pseudechis porphyriaca*), three Brown Death Adders (*Diemenia textilis*), six Short-headed Death Adders (*Hoplocephalus curtus*) from Australia, a Yellow-headed Conure (*Conurus jendaya*) from South-east Brazil, deposited; six Garter Snakes (*Tropidonotus ordinatus*), six Dekay's Snakes (*Ischnognathus dekayi*), three Spotted-headed Snakes (*Ischnognathus occipito-masculatus*),

three Grass Snakes (*Cyclophis vernalis*), a Hog-nosed Snake (*Heterodon platyrhinos*) from Montreal, received in exchange; two Patagonian Cavies (*Dolichotis patachonica*), two Ypecaha Rails (*Aramides ypecaha*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

NOVEMBER METEORS.—With the July number of *Monthly Notices R.A.S.* a circular is issued by G. Johnstone Stoney, calling the attention of astronomers to the approach of the great secular maximum of the Leonids, which is due about 1899 or 1900. It is probable that this swarm was drawn into the solar system by the planet Uranus about February or March A.D. 126, and careful observations during the next few years may furnish materials for confirming or rejecting this hypothesis. Photography should be employed as widely as possible, and wherever practicable the time of appearance of each meteor recorded. Accurate simultaneous observations from different stations will be of exceptional use. The radiant-points and times of apparition of all meteors should be exactly noted, commencing a few nights before, and continuing some nights after, November 14 and 15.

PLUMB-LINE DEVIATIONS.—M. Messerschmitt, who has been for some time engaged in the determination of latitude and azimuths of a series of points in the Swiss Triangulation, has communicated (*Ast. Nach.*, No. 3365) the results of his most recent investigations. It may be recalled that M. Messerschmitt's first determinations were made in West Switzerland, and these were followed by further researches in the north of the country, which corroborated his previous results. The present paper is concerned with observations made on a line drawn approximately north and south through the centre. Collecting his results into a table showing the difference between geodetic and astronomical latitude, and arranged in order of increasing distance from the equator, a systematic deviation from the vertical is clearly shown. In the midst of the mountains (around Andermatt for example) these deviations are quite small. Going south they increase rapidly, and attain a negative maximum of 20″ (astronomical—geodetic) towards Lugano. A positive maximum occurs about Goschenen, the entrance to the Gotthard Tunnel; and still further north, the difference diminishes again, and changes sign about the latitude of Zürich. Schaffhausen shows again the position of negative maximum. The position of the mountain chains generally explains these variations.

An investigation, founded on these deviations of the plumb-line, of the form of the surface of the earth for a meridian length of about 200 km. through the Gotthard district, discloses the fact that the ellipsoid sinks everywhere below the geoid. Selecting as a zero point that position where no deviation from the vertical exists (47°·1 15′ lat.), the greatest difference between the two surfaces occurs near Airolo (the southern exit of the tunnel), where it amounts to nearly five metres. Going southwards from this point the surface sinks gradually, and approaches the ellipsoid before the valley of the Po is reached.

THE HAMBURG OBSERVATORY.—Prof. Rumker's report of the observatory work during the year 1895, shows that the activity of the various departments is fully maintained. The observations with the equatorial have mainly consisted in deriving the positions of small planets and comets, and of the fainter stars with which the nebulæ, whose places have been published in a communication from the observatory, have been compared. With smaller instruments attention has been given by Dr. Hänig to variable stars and occultations by the moon. With the meridian instrument, in addition to observations required for the accurate distribution of time signals, arrangements have been made for observing stars in the degree 80–81 N. Decln. down to 9·3 mag. In addition to this varied work, the attention of the staff has been called by Dr. Auwers and others to discrepancies between the places of stars in the Hamburg catalogue, and those recently obtained in the "Astronomischen Gesellschaft" zone catalogue. This has necessitated much searching of old records, and in some cases the detection of errors, which will be published in a communication from the observatory.

THE DUNSINK OBSERVATORY.—The seventh part of the astronomical observations and researches made at Dunsink, and published under the direction of Prof. Rambaut, contains the meridian places of 717 stars, of which upwards of 2000 observations have been made. These stars have been selected on account of suspected large proper motions, and the observations, interrupted as they have been from several causes, have been spread over eleven years. But, nevertheless, the accuracy maintained throughout is of a very high degree. From an examination of the separate results, the probable errors in R.A. and Declination are, respectively, $\pm$ 0″·037, and $\pm$ 0″·505. This error is probably increased by the uncertainty of the proper motion in many cases, and does not fully express the accuracy of the work. The Pistor and Martin's meridian circle, with which the observations have been made, has been frequently reversed in the course of the work, and the determination of latitude, on which great care has been bestowed, is slightly different in the two positions. With Clamp West the resulting latitude is 53° 23′ 13″·05, and with Clamp East three-tenths of a second less. The value used in the final reduction is 53° 23′ 13″·00, and the results, it is believed, coincide very closely with Auwers' fundamental system. The cause of this systematic difference in the latitude, however, has not been satisfactorily explained.

OBSERVATORY OF MOSCOW.—The last issue of the *Annals* of this Observatory (series 2, vol. iii. part 2, 1896) contains several papers of general interest. The director, W. Ceraski, contributes the following articles: (1) "Photometry of the star cluster χ Persei," in which he gives the measures of the magnitude of seventy stars of the group, determined with a Zollner photometer on a 10-inch refractor. One star he finds to be variable, and recommends its further study. (2) "Observations of eclipses of Jupiter's satellites without photometric appliances," using eye estimates of relative magnitude compared with some neighbouring star of known brightness. (3) "On the temperature of the sun," in which he gives the inferior limit to be about 3500° C. (4) "A new method for the electrical comparison of pendulums."—P. Sternberg discusses the photographs he obtained during the transit of Mercury on May 9, 1891, and also contributes an important description of his determination of the variation of latitude at Moscow.—B. Modeston gives a full description of the calculation of double-star orbits by the methods of Kowalski and Encke respectively. —S. Blajko, as the result of thirteen photometric measures of the magnitude of Mira Ceti during the winter of 1894–5, finds evidence of a secondary maximum in its light curve, occurring about a month previous to the highest maximum, the magnitudes at the secondary and principal maxima being about 3·5 and 3·16 respectively.

THE SOLAR ECLIPSE OF APRIL 16, 1893.

M. DESLANDRES has now issued his report on the work accomplished by the French expedition to Fundium, Senegambia, for observations of the total solar eclipse of April 16, 1893. Some of the results obtained have already been made known, and these are now brought into connected order and discussed. A full account is also given of the general objects and organisation of the expedition. The programme decided upon included the photography of the corona, a photographic study of the coronal spectrum, especially in the ultra-violet, and a spectroscopic study of the movements of the corona.

The report is of special importance in view of the approaching eclipse, for the reason that reference is made to several points which may serve as a guide in future operations. For example, M. Deslandres' experience indicates that for the corona pictures plates of moderate sensitiveness give better results than the plates of greater rapidity. Another practical suggestion is that at least two cameras should always be employed in the search for an intra-mercurial planet; M. Deslandres found it impossible to determine whether certain spots on the single plate which he obtained represented stars or photographic defects.

The general results relating to the coronal spectrum are thus stated: (1) The continuous spectrum of the corona, which forms the greater part of its light, is most intense on the red side, relatively to the spectrum of the disc, and the difference appears to become greater as the point considered is further removed from the photosphere. (2) The spectrum of dark lines, under very favourable conditions, did not appear at 5′ from the sun's limb; at this height the light diffused by the coronal particles is still too feeble with respect to their own light. (3) The luminous gases of the corona, indicated by the fine lines, have not the same intensity or composition in different parts of

the corona, or at different heights; further, they most frequently do not correspond to elements known upon the earth.

Special interest attaches to the investigation of the rotation of the corona by observing or photographing the displacement of lines in the spectrum at some distance from the limb on each side of the equator. No photographic impression was secured with the fourth order spectrum of a diffraction grating, adjusted for H and K, and, although the eclipse occurred at a maximum of sun-spots, 1474 K was too feeble in the second order spectrum to permit any trustworthy measures to be made visually. A successful photograph of the H and K lines was obtained, however, with a 3-prism spectroscope attached to a 6-inch refractor, one half of the slit being exposed on the west and the other on the east side of the corona. The measured velocity of 6·8 km. per sec. has led M. Deslandres to conclude that the equatorial part of the corona moves very nearly with the same angular velocity as the photosphere. This result must be received with caution until confirmed by further researches, as the photographs taken at the same moment by Mr. Fowler give no indications of the presence of H and K in the true coronal spectrum. It is pointed out that this research may be simplified in future by making only one exposure, placing the slit radially, so that the velocities may be determined from the inclination of the lines, as in the recent researches on Saturn's rings.

In the last chapter of the report, various hypotheses as to the nature of the solar atmosphere are reviewed, and an electrical theory is propounded. It is pointed out that, notwithstanding the diversity of appearances, there is really a great similarity between the solar and terrestrial atmospheres, and the report ends as follows: "Terrestrial meteorology and solar physics, which are separated by the necessity for the division of work, are in reality connected sciences, which, by the nature of things, ought to be studied together."

THE RÖNTGEN RAYS.[1]

PROF. RÖNTGEN, of Wurzburg, at the end of last year published an account of a discovery which has excited an interest unparalleled in the history of physical science. In his paper read before the Wurzburg Physical Society, he announced the existence of an agent which is able to affect a photographic plate placed behind substances, such as wood or aluminium, which are opaque to ordinary light. This agent, though able to pass with considerable freedom through light substances, such as wood or flesh, is stopped to a much greater extent by heavy ones, such as the heavy metals and the bones; hence, if the hand, or a wooden box containing metal objects, is placed between the source of the Röntgen rays and a photographic plate, photographs such as those now thrown on the screen are obtained. This discovery, as you see, appeals strongly to one of the most powerful passions of human nature, curiosity, and it is not surprising that it attracted an amount of attention quite disproportionate to that usually given to questions of physical science. Though appearing at a time of great political excitement, the accounts of it occupied the most prominent parts of the newspapers, and within a few weeks of its discovery it received a practical application in the pages of *Punch*. The interest this discovery aroused in men of science was equal to that shown by the general public. Reports of experiments on the Röntgen rays have poured in from almost every country in the world, and quite a voluminous literature on the subject has already sprung up.

In view of the general interest taken in this subject, I thought that the Röntgen rays might not be an unsuitable subject for the Rede Lecture.

Before discussing these rays themselves, I think it may perhaps make matters clearer if I call your attention to one or two of the phenomena which accompany the discharge of electricity through gas at a low pressure. I have here a bulb from which the air has been taken until the pressure has been reduced to about 1/10000 part of the atmospheric pressure. When the electric discharge passes through this bulb you see that there is considerable luminosity in the gas in the bulb, except in a region round this terminal—the negative one; this region, where the luminosity is so deficient, is called the negative dark space. In this bulb there is no phosphorescence on the glass, and I may say no emission of Röntgen rays. If I were still further to reduce the pressure of the gas in this bulb, this dark space would expand and encroach on the luminous part of the discharge, and would, when the pressure got very low, reach the walls of the tube; the expansion of the dark space diminishes the luminosity in the gas, but we find that where the dark space reaches the glass of the tube the glass itself becomes luminous, until finally at very low pressures we get to the state of things shown by this tube, where the luminosity is all on the glass, and little or none is to be observed in the gas. Röntgen rays are produced by this bulb, though not by the other.

There is one feature in this tube to which I must call your attention: you see that there is a shadow on part of the tube; this shadow is thrown by a mica cross fixed between the negative electrode and the wall of the tube, and if we observe the shape of the shadow we see that any point of the tube is in shadow if the line joining that point to the negative electrode passes through the mica cross. We thus conclude that we have something starting from the negative electrode, travelling in straight lines, and producing phosphorescence when it reaches the glass, and, further, that this something is stopped by the mica cross. This something which travels in straight lines from the kathode is called the kathode rays: these rays are of great interest in relation to the subject of this lecture, for the kathode rays seem to be the parents of the Röntgen rays. Let me call your attention to the effect produced by a magnet on these rays: you see that when the magnet is brought near, the shadow of the cross is displaced; this shows that the direction of the rays casting the shadow have been deflected by the magnet, thus the kathode rays are deflected by a magnet. We shall see later on that the Röntgen rays, on the other hand, are not so affected. This is one of the most striking differences between the parent—the kathode rays—and the child, the Röntgen rays. The effects of the kathode rays inside the tube were discovered more than twenty years ago by Crookes and Goldstein: it is only quite recently, however, that any effects produced by these rays outside the tube have been observed. In 1894 Lenard, using a tube of the kind shown in the diagram (Fig. 1), where the kathode

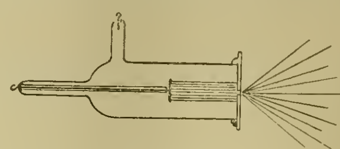


FIG. 1.

rays struck against a window made of very thin aluminium, found that if he placed outside the tube in front of the window a screen covered with a phosphorescent substance, pentadecaparatolyketon, it became phosphorescent; he found, further, that a photographic plate placed behind the window was affected—nay, that this plate was affected even though he placed in front of it a plate of aluminium or a thin quartz plate—in fact, he took a photograph through aluminium and quartz; he thus obtained two of the most prominent phenomena shown by the Röntgen rays. In fact, we know from the researches of Röntgen that the Röntgen rays must have been present and played a part in these experiments. Lenard himself ascribed the effects he observed to kathode rays which had penetrated the aluminium window, and indeed it would seem that something in addition to the Röntgen rays must have been present, as Lenard found that the position of the phosphorescent patch was affected by a magnet, while the Röntgen rays themselves are, as we shall see, not influenced by such an agent.

I now come to the consideration of the Röntgen rays themselves, and shall endeavour to repeat some of the experiments by which Röntgen established their existence. The apparatus consists of a tube exhausted to such a low pressure, that when the electric discharge passes through it there is an abundant supply of kathode rays; these rays strike against a metal plate in the bulb. This metal plate is not essential for the production of the rays, and was not present in the bulbs used by Röntgen; it, however, considerably increases the efficiency of the bulb.

When the electric discharge passes through this bulb, the region round it is the seat of some very remarkable phenomena. I have here a screen coated with a phosphorescent substance,

[1] The Rede Lecture, given at the University of Cambridge, on June 10, by Prof. J. J. Thomson, F.R.S.

potassium platinocyanide; though this screen is opaque to ordinary light, you will see that it phosphoresces when placed in the neighbourhood of the bulb. This phosphorescence is due to something radiating from the bulb, because when I place this piece of metal between the bulb and the screen, a sharp shadow of the metal is thrown on the screen. The metal is opaque to these radiations. If, however, I place a piece of wood, about an inch thick, between the bulb and the screen, you will hardly be able to see a shadow; so that this board, though opaque to ordinary light, allows those rays to pass through with considerable freedom. The lighter the substance the more easily is it penetrated by these rays; thus the very light metal aluminium is very transparent, as you will see by the poor shadow it casts upon the screen. This property has been used to detect real gems from paste, as the diamond, consisting of the light element carbon, is much more transparent than an artificial one made of heavy silicates. Since light objects are, roughly speaking, transparent, while the heavy ones are opaque, if we have a mixture of heavy and light objects between the screen and the bulb, the heavy ones will throw a shadow, the lighter ones will not. We can thus detect dense objects even when surrounded by opaque ones, provided the latter are light. [Experiments throwing shadows of jewellery in cases, hands, &c., upon the screen.] Prof. Lodge has in this way been able to see through a yard of timber. We seem here to have the realisation of Sam Weller's aspiration after an optical arrangement which would enable one to see through "a flight of stairs and a deal door."

I will now endeavour to show that in order to have Röntgen rays you must have kathode rays to start with. I will produce in the bulb, which I have used for the production of the Röntgen rays, a discharge of another kind, viz. an electrodeless discharge in which the discharge, instead of travelling between metallic terminals in the gas, travels round a closed circuit in the gas. In this way we have no kathode and no kathode rays; you see that though a bright discharge passes through the bulb, far brighter than in the previous case, no luminosity is produced on the screen.

One very remarkable property discovered by Röntgen of these rays, is that they are not bent when they pass from one medium to another. We can show this in the following way. I place in front of the bulb this thick plate of metal, in which a vertical slit has been cut; the metal stops the rays, so that we get on the screen a bright luminous vertical band. Now I place between the slit and the screen this wooden prism, which covers up the lower, but not the upper, half of the slit; if the rays which came through the slit were refracted, then the lower part of the bright band would no longer be in the same straight line as the upper part. You see, however, that the two halves still remain on the same line; the only effect produced by the wooden prism has been to make the lower half somewhat dimmer than it was before.

Again, these rays are not deflected by a magnet; to prove this, we throw the shadow of two brass tubes on the screen, and observe the shadows before and after a horse-shoe magnet has been introduced into the tubes; you see that no appreciable effect is produced by the introduction of the magnet.

The absence of refraction leads us to expect that there would be little regular reflection of the Röntgen rays, and this conclusion has been confirmed by numerous experiments. At grazing insistence, however, Joly of Dublin has been able to detect a small amount of regular reflection. Though there is but little regular reflection there is an appreciable amount of what, to avoid any speculation as to its nature, has been called by Sir George Stokes "diffuse return" of the rays; this was discovered by Röntgen himself, and is rendered very evident by an experiment of Lord Blythswood We do not know yet, however, whether the rays coming off from the metal plate are of the same kind as those which fall upon it, or whether they are slightly different. If they are of the same kind, then the effect would resemble the diffuse reflection from a piece of ground glass; if they are different, it would indicate that the piece of metal illuminated by these rays became itself a source of rays not quite of the same kind as those which fall upon it, just as when a solution of quinine is exposed to the invisible ultra-violet light it emits not ultra-violet light like that which fell upon it, but visible blue light. This point might be settled by measurements of the rates of absorption of the incident and "diffusely returned" light.

That the Röntgen rays are not all of the same kind, has been shown in several ways, of which, however, I have only time to mention one. Mr. McClelland, working in the Cavendish Laboratory, found that if he took a plate of tinfoil and a layer of water, and adjusted the thicknesses so that they exerted the same absorption on the Röntgen rays given out from one bulb, they did not necessarily produce the same absorption in the rays from another bulb, showing that the rays from the one bulb were not the same as those from the other.

Röntgen discovered that the rays not only made certain substances phosphorescent, but that they affected a photographic plate; so that if we replaced the phosphorescent screen in our experiment by a photographic plate, we should get a permanent impression of the picture, which would be thrown on a phosphorescent screen placed in the position of the photographic plate. To obtain these photographs all that is necessary is to protect a photographic plate from ordinary light by thick cardboard or aluminium, and place the object to be photographed between the bulb and the plate; after an exposure varying with the nature of the object and the state of the bulb, photographs of the kind which are now so well known can be obtained.

One very marked feature of these photographs is the sharpness of the detail; this shows that the origin of the rays must be confined to a comparatively small region. If these rays came from an area comparable with that occupied by the phosphorescence on the walls of the bulb used to produce the rays, the luminosity from one part of the screen would throw one pattern on the screen, while the rays from another portion would throw another pattern; the superposition of these patterns would produce a blurred image. To illustrate this point, I have here two photographs of the same thing—one taken by the Röntgen rays, the other taken by an incandescent lamp with walls of frosted glass, of about the same size as the bulb used to produce the Röntgen rays, and placed in the same position; you see that the photograph taken by the Röntgen rays is quite sharp, while that taken by the electric lamp is much blurred. This shows that the Röntgen rays do not come from an area nearly so extended as the phosphorescent part of the glass. We can investigate the place of origin of these rays in various ways, by observing the law of diminution with the distance of the effects due to these rays, by taking pin-hole photographs, by observing the direction of the shadows cast by a series of opaque bodies; the result of such observations shows that Röntgen rays are produced when the kathode rays strike against a solid obstacle. Cases have been observed by Lord Blythswood and by Rowland, which seem to show that this is not the only source of these rays.

The experiments made on these ray have not led to any result absolutely decisive as to their nature, but we can profitably discuss the question whether the facts known about these rays oblige us to regard them as due to a new form of energy, or whether they are consistent with these rays being a variety of some form of energy already known to us; before calling in a new form, we ought to be quite sure that it is necessary to abandon the old. The rectilinear propagation of these rays, their powers of producing phosphorescence and of affecting a photographic plate, their insensibility to a magnet, suggest that of the old forms of energy light is the one to which these rays are most closely allied. We are acquainted with so many varieties of light (by light I mean transverse vibrations propagated with a definite velocity) with such widely different properties, that we can well contemplate the existence of other kinds with still different properties. We know, for example, the ultra-violet light of very small wave-length, the subject of classical researches by Sir George Stokes, which, though it affects a photographic plate, does not affect the retina, and passes through bodies with such difficulty that the most ultra-violet kind is quenched after passing through a few millimetres of air; then we have the visible light able to affect the retina, and able to pass through great lengths of some substances which are opaque to the ultra-violet rays though stopped by very small thicknesses of others; then we have the longer waves of radiant heat given out by a hot body below the temperature at which it becomes luminous. These are not visible, have but little effect on a photographic plate, and are able to traverse substances opaque to both ultra-violet and visible light. Then we have the waves emitted by vibrating electrical systems, which neither affect the retina nor a photographic plate, which, as Mr. Rutherford has shown, are able to traverse the walls of the houses and the bodies of the inhabitants of about three-quarters of a mile of a densely populated part of Cambridge, and which are so different

in properties from ordinary light that it required the genius o Clerk-Maxwell to recognise them as light at all. I shall have to call your attention to another kind of light, discovered lately by Becquerel. It will doubtless be urged that widely as these kinds of light differ from each other in some respects, they all are bent when they pass from one substance to another, while the Röntgen rays, as we have seen, are not refracted. This objection to the possibility of the Röntgen rays being a kind of light, formidable as it appears at first sight, loses all its force when more closely examined. We know cases in which light passes through substances without being refracted; thus Kundt found that certain rays could pass through gold without being refracted, while other rays were bent the wrong way. Stenger has lately found that certain blue rays can pass through fuchsin, and other slightly different ones through Hofmann's violet, without being bent. Perhaps, however, the most striking testimony to there being nothing inconsistent in the idea of a kind of light which is not refracted, is afforded by one of the last investigations undertaken by von Helmholtz, and published about three years ago. Von Helmholtz investigated what, on the electromagnetic theory of light, would be the bending experienced by light of different frequencies passing through an ideally simple substance, one whose spectrum consists of only one line. The result of his investigation is shown in this curve (Fig. 2), where the abscissæ represent the frequency of the light, the ordinates the refractive index. On the part of the curve from *f* to *g*, you see that the refractive index increases as the frequency increases; this corresponds to the normal spectrum where the blue rays are more refracted than the red. After passing *b* the curve dips down; this means that the greater the frequency the less the bending, in other words, the blue rays tend to be bent more than the red. We know many instances of this, it is called anomalous dispersion. Then we get to

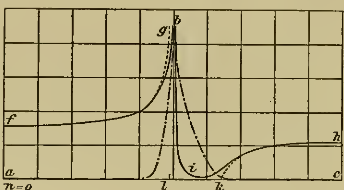


FIG. 2.

the part of the curve about *i*, where the refractive index is less than 1; that is, where the rays are bent the wrong way. We have examples of this, as Kundt has shown, in the case of gold, silver and copper; but the most interesting part of the curve for our purpose is the last part, where, after dipping below the line of no-bending for a short distance, it approaches it and practically coincides with it for all frequencies greater than *a h*; so that, on this theory there would practically be no bending for all waves whose frequency exceeds a certain value. Thus, so far from the absence of bending being a proof that the Röntgen rays are not light, this absence of bending is exactly what we should expect if these rays were light of very great frequency.

A characteristic feature of all varieties of light is the existence of polarisation, and polarisation is indisputable evidence of transversal vibration; hence, many experiments have been made to see whether any polarisation of these rays could be detected. All these experiments have practically been confined to seeing whether the Röntgen rays could traverse two plates of tourmaline more freely when the axes of the two plates are parallel than when they are crossed; there is a great difference in the transparency to ordinary light in the two cases. The results of these experiments are somewhat conflicting. Prince Galitzine and M. de Karnojitsky are of opinion that they have succeeded in detecting a slightly greater absorption of the rays when the axes are crossed than when they are parallel; on the other hand, Becquerel, Mayer, and I were not able to detect any appreciable difference in the two cases. If the result of Prince Galitzine should be confirmed, it would prove beyond cavil that these Röngten rays were light; but even if the presence of polarisation is not definitely established in this case, it does not follow that these rays can not be polarised—the methods for polarising one kind of light may not be successful when used for another. For example, a wire bird-cage will polarise the long electrical waves, but will not affect the shorter waves of radiant heat, much less those of visible light. By winding exceedingly thin wires close together on a framework, Rubens and Du Bois were able to polarise the waves of radiant heat, the wave-lengths of which are long compared with those of light. This arrangement, however, is much too coarse to polarise visible light, much less ultra-violet light. And it is possible, and indeed likely, that the structure of the tourmaline, though fine enough to polarise ordinary light, may not be fine enough to polarise the Röntgen rays.

So far, I have confined myself to showing that there is nothing in the effects known to be due to these rays inconsistent with their being a variety of light. I must now pass on to some evidence of a more positive character. Since the discovery of the Röntgen rays, Becquerel has discovered a new kind of light, which in its properties resembles the Röntgen rays more closely than any kind of light hitherto known. Becquerel found that certain uranium salts emitted, after being exposed to the sunlight, radiations which, like the Röntgen rays, could pass through plates of aluminium or of cardboard, and affect a photographic plate behind. I have here a photograph of a perforated piece of zinc, which has been taken by Becquerel's method by simply scattering over the zinc plate powdered uranium nitrate, and placing it over a photographic plate well protected from ordinary light. After a long exposure of from twenty to forty hours, the photograph now on the screen was taken. Becquerel has shown that the radiation from the uranium salts can be polarised, so that it is undoubtedly light; it can also be refracted. It forms a link between the Röntgen rays and ordinary light, it resembles the Röntgen rays in its photographic action in power of penetrating substances opaque to ordinary light, and in the characteristic electrical effect, while it resembles ordinary light in its capacity for polarisation, in its liability to refraction. The persistence of the radiation is very remarkable. Becquerel found that the potassium-platinum compound of uranium went on emitting these radiations with nearly undiminished zeal for fifteen days after it had been exposed to the sunlight. It would seem that under the influence of sunlight some change in the chemical or physical nature of the substance occurred, and that after the sunlight was cut off, the substance gradually went back to its original state, and that while doing so it emitted this peculiar radiation. The radiation from the uranium salts is of especial interest from another point of view. Sir George Stokes has shown that in the case of phosphorescence caused by sunlight or the arc lamp, the light emitted by the phosphorescent body is of longer wave-length than the light causing the phosphorescence; in the case, however, of the phosphorescence discovered by Becquerel, the light emitted is of a shorter wave-length than the incident light. The case resembles that called calorescence by Tyndall, when the body placed in a focus of dark radiant heat becomes luminous and gives out the shorter luminous waves.

From this discovery of Becquerel, we may conclude that besides the vibrations emitted by luminous bodies with which we have hitherto been acquainted, there are others having a much greater frequency and, it may be, arising in a different way.

To sum up, we may say that though there is no direct evidence that the Röntgen rays are a kind of light, there is no known property of these rays which is not possessed by one or other of the forms of light.

One of the most remarkable phenomena connected with these rays is the way in which the absorption depends upon the density of the body; if we measure the transparency of a series of bodies, we find that the order of opacity is the same as the order of their density. No other factor in the constitution of the body seems comparable in importance with density. In this respect, the relation between the opacity and the other properties of a body in the case of the Röntgen rays is simpler than that for luminous waves or electric waves. There seems no simple relation between the density of a body and its transparency to visible radiation or electrical vibration; in the case of the Röntgen rays, however, it seems the greater the density the greater the opacity. This appears to favour Prout's idea that the different elements are compounds of some primordial element, and that the density of a substance is proportional to the number of the primordial atoms; for if each of these

primordial atoms did its share in stopping the Röntgen rays, we should have that intimate connection between density and opacity which is so marked a feature for these rays.

I now pass from the consideration of the rays themselves to some of the effects they produce on bodies through which they pass.

There seems considerable evidence that the energy associated with these waves is small. I am not acquainted with any effects produced by them which involve the expenditure of an amount of energy comparable with that emitted in a second by a candle. They do not produce any appreciable rise in temperature when they fall on the thin metallic strips of a bolometer. Mr. Skinner has found that they exert no appreciable effect on the combination of hydrogen and chlorine, though this is a good test of the intensity of very faint light; and, what is more unfortunate, they do not exert any of those deleterious effects on bacteria which are fortunately associated with ultra-violet light. Some of the other effects exerted by ultra-violet light seem to be associated with these rays; thus some observers who have had undue curiosity about their bones, and have in consequence exposed their hands frequently to these rays, have found that the hand so exposed became sunburnt. There seems considerable evidence, too, that these rays are not good for the eyes, though it is difficult to disentangle any distinctly injurious effect due to the rays from the bad effect that may be produced by the straining of the eye in the endeavour to see only a faintly luminous object.

There is one property of substances which seems peculiarly suitable for testing if these rays affect the substance through which they pass; it is the property of transmitting electricity.

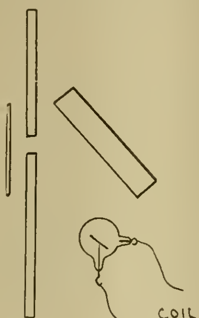


FIG. 3.

When we investigate the effect of the Röntgen rays on this property, we find the remarkable result that bodies which, when shielded from these rays, insulate to all appearance, perfectly allow electricity to pass through them when exposed to the action of these rays. I will, first of all, show an experiment illustrating this property in the case of gases which in their normal state are of all substances the most perfect insulators. The details of the experiment are shown in the diagram (Fig. 3). The coil and bulb are placed in this box, lined inside with tin-plate, and covered over the top with sheet-lead. A hole is cut in the box just over the bulb, and this hole is covered with a plate of aluminium, which is transparent to these rays. The air space between the electrodes is placed over this hole. One electrode is connected to one pair of quadrants of the electrometer, the other electrode is connected to one terminal of a battery, the other terminal of which is to earth; the two pairs of quadrants of the electrometer are connected together and with the earth, and the connection between them broken. If there is no leakage across the air space, the needle of the electrometer will remain at rest. You see it does so when the coil is not in action. As soon, however, as the coil is turned on, the spot of light moves rapidly across the scale, showing that electricity is passing across the air space. The rapidity of movement of the spot of light is a measure of the rate of leak. Now the electrical leakage produced by these rays depends on the nature of the gas. The gas I have just used was air. I will now replace the air by another gas—chlorine. Again you see the leak, but it is now much faster than before. Mr. McClelland and I have investigated the rate of leak in different gases, and we find that they can be arranged in the following order: hydrogen, coal gas, ammonia gas, air, carbonic acid gas, sulphuretted hydrogen, chlorine, mercury vapour.

That the gas itself is put into a peculiar state by the passage through it of these rays—a state which it attains for an appreciable time—is shown by the following experiment, which I described some time ago in NATURE. I have here an electrode shielded from the direct action of these rays. I charge it to a high potential, and even though the rays are on, it does not leak. I now blow some of the air through which the rays have passed on to the electrode, and you see at once we get a rapid leak. The rate at which electricity passes through the gas

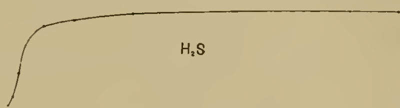


FIG. 4.

depends upon the pressure; the lower the pressure the slower the leak. Mr. McClelland and I found that for an air space of about 1 cm. the rate of leak over a considerable range of pressure varies as the square root of the pressure. In some experiments recently made by Mr. Rutherford and myself, we found that using a constant potential difference the rate of leak was smaller across a very thin plate of air than across a thicker one; it thus appears that the process of conduction through a gas is one that requires a considerable amount of room.

Another very interesting point about the rate of leak is the connection between the rate of leak and the electromotive force. This can, perhaps, be most easily understood by means of a curve (Fig. 4). The ordinate represents the rate of leak, the abscissa the electromotive force. At first, when the E.M.F. is small, the curve is a straight line, showing that the current is proportional to the electromotive force; in other words, that the conduction of electricity through the gas, like the conduction through metals and electrolytes, obeys Ohm's law. But it is

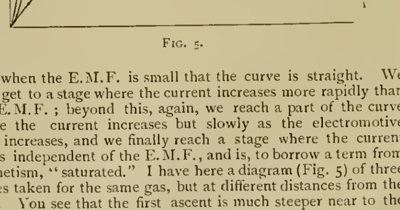


FIG. 5.

only when the E.M.F. is small that the curve is straight. We soon get to a stage where the current increases more rapidly than the E.M.F.; beyond this, again, we reach a part of the curve where the current increases but slowly as the electromotive force increases, and we finally reach a stage where the current seems independent of the E.M.F., and is, to borrow a term from magnetism, "saturated." I have here a diagram (Fig. 5) of three curves taken for the same gas, but at different distances from the bulb. You see that the first ascent is much steeper near to the bulb—that is, when the rays are strong than when it is far away and the rays are weak, and practical saturation is attained sooner when the rays are strong than when they are weak. These curves bear a remarkable resemblance to those which represent the relation between the magnetisation of a piece of iron and the magnetic force acting upon it. When the rays are strong, the curve is like that of soft iron; when the rays are weak, it is like steel.

Gases are not the only substances that conduct when trans-

mitting these rays; solids also conduct, though the conductivity obeys different laws and only lasts for a short time. The conduction through solids very closely resembles the phenomenon called "electric absorption," a well-known example of which s the residual charge of a Leyden jar.

I have here some experiments which illustrate the effect of the Röntgen rays on solids. In the first of these we have a lead cylinder with a thin base made of aluminium. At the bottom of the cylinder there is a thin layer of solid paraffin; on the top of this, and sticking to it, there is a large leaden disc, over which paraffin has been poured, so that the disc is entirely embedded in the paraffin (Fig. 6). This cylinder rests on the aluminium window in the iron chest containing the coil and the tube, this window being very much smaller than the lead plate in the paraffin. I now connect the lead plate to one pair of quadrants of a highly charged electrometer, and then connect the two pairs of quadrants together and with one of the poles of a battery of 200 small storage cells, the other pole of which is connected with the iron chest, and so with the earth. I now disconnect the quadrants from the battery, and then the quadrants from each other. There is now very little movement of the spot of light reflected from the mirror of the electrometer. When we turn on the Röntgen rays, however, the spot of light begins to move, and though the movement is small compared with that which occurred in the experiment with air, it is quite decided. The rapidity with which the spot of light moves soon, however, begins to decrease, and after a short time becomes almost

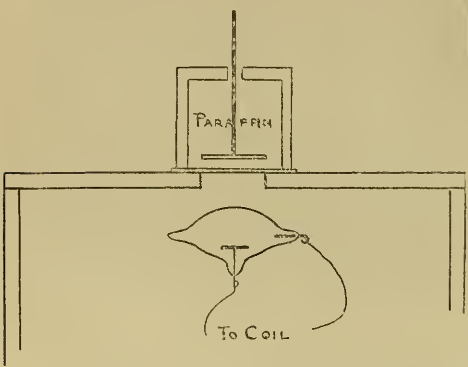


FIG. 6.

inappreciable. I now discharge the lead plate by connecting it and both pairs of quadrants of the electrometer to earth for a short time, then keeping one pair of quadrants connected with the earth, and leaving the other connected with the lead plate, we see that when the rays are off there is a very slight movement of the spot of light in the opposite direction to the original deflection; this is due to the leaking out of the "residual charge" This movement is, however, greatly increased as soon as the rays are turned on, and continues until we get quite a large deflection; "the residual charge," or polarisation in the paraffin, has then been enormously increased by the rays. The conductivity of the paraffin under these rays resembles in its properties that of the insulating sheath of a telegraph cable. In testing the resistance of such a sheath, the current passing through it does not remain constant, it rapidly falls off in intensity; and if after the electromotive force has been applied for some time it is removed, and the inside and outside of the sheath connected with the terminals of a high-resistance galvanometer, a current flows through the galvanometer, and this current is in the opposite direction to that which originally flowed through the sheath.

Ebonite shows the effect of the Röntgen rays in increasing the conductivity even better than paraffin. I have here a plate of ebonite about 1 mm. thick, coated on both sides with tinfoil. I put this on the aluminium window, and on the top of the ebonite plate I place a lead disc, which is much larger than the aluminium window; the object of this disc is to prevent the Röntgen rays from striking against the wire connected with the disc, and so discharging the disc through the air. That it is effectual in doing this, is proved by there being no leak when the rays are on, and the wire (raised to a high potential) disconnected from the disc. If we now repeat with this plate of ebonite the experiments we previously tried with the paraffin, we get similar but decidedly larger results. I may mention that different specimens of ebonite vary considerably in the magnitude of this effect. There is one variation of the preceding experiments which is of some interest. I will charge up the ebonite plate without putting the Röntgen rays on at all; on discharging, you see that the electrometer indicates that the "residual charge" is coming out. I keep discharging the disc until the residual charge is almost inappreciable. I now for the first time put on the rays, and you see that the residual charge or polarisation, which could not previously be detected, now becomes quite marked. These experiments show how greatly the properties of bodies are modified by the Rontgen rays, and show that by their discovery physical science has received an agent which promises to be of the greatest service in investigating some of the properties of bodies which are now most urgently pressing for explanation.

LONDON UNIVERSITY COMMISSION BILL.

THE second reading of the London University Commission Bill was agreed to by the House of Lords on Thursday last. A full report of the debate upon the Bill was given in the *Times* of Friday, and the following abridgement of it will show the favourable feeling that exists for the appointment of the Statutory Commission to deal with the reconstitution of the University.

The Duke of Devonshire moved the second reading of this Bill. He said: As I made a short statement of the circumstances that have led to the introduction of this Bill when I moved for leave to introduce it, it will not be necessary for me to detain your lordships for any long time on this occasion. The opposition to the Bill, of which I indicated the possibility, has manifested itself in the form of a statement purporting to proceed from two bodies entitled respectively the University Defence Committee and the Gresham Commissioners' Scheme Amendment Committee. It is not stated how those committees are composed, and whilst I have no doubt that they fairly represent those parties who are known to be opposed to legislation on those lines, I do not think it will be contended that the body of opinion which is represented by those committees can be compared for a moment, either in weight or as regards scientific or educational experience, with that body of opinion which in various ways has given expression to its adoption of the principles upon which this Bill is founded. I think that in moving the second reading it may be sufficient if I say that, in my opinion, the arguments which are brought forward in this case do not establish any reason why the Bill should not be read a second time. There may be some points which are referred to in that case which may be worthy of attention in Committee, and I think that some of the statements may be eminently deserving of the attention of the Statutory Commission if it should be appointed under this Bill. Lord Davey has expressed his willingness to accept the position of chairman of this Commission if it should be appointed, and I trust that before the Bill leaves your lordships' House, or at all events as soon as there appears to be any possibility or probability of its being passed through the other House, I shall be in a position, in conjunction with him, to state the names of those gentlemen who it is proposed shall form the entire Commission. With this explanation I beg to move that this Bill be read a second time.

Lord Herschell: As I have the honour to be Chancellor of the University of London, it is only natural that I should desire to say a few words on the present occasion. The objections to the measure may, I think, be put under two heads. It is alleged that the scheme of the Commission of which Lord Cowper was chairman, even when subjected to the scrutiny and modification of the proposed Statutory Commission, would involve two consequences—that it would lower or tend to lower the standard of the degrees, and that it would be unfair or tend to unfairness towards those students who sought to obtain a degree without having been connected with any college or collegiate instruction. The opponents to the scheme, both in the statement they have

recently made and in previous statements, always seem to me to assume that those will be the consequences. Their statement is founded upon assumption rather than any proof or evidence. If the members of the Senate shared the view of the opponents of the scheme that the consequences which they assumed would, in fact, necessarily result, I venture to say that the Senate of the University would have been found in the front rank of opposition to the scheme, and if they support the scheme it is not because they are indifferent either to the standard of education or to the interests of the external students, but because they believe that the present work of the University may be made even more valuable than it has been without any such risk as the opponents of the scheme consider must necessarily attach to it. The fear seems to be that the scheme which has been proposed would give the teachers in London schools and colleges more power in the direction of examinations and course of study than they possess at present, and that a likely consequence of their obtaining that greater power would be a lowering of the standard of education at the University. But here again we are not without experience. First let me say that the high standard that has been maintained has been largely due to the examiners. Who have the examiners been who have thus maintained the standard of the examinations? They have very largely consisted of the teachers of the London schools and colleges. That is a matter of experience which is of much more value than any mere assumption. There is a very large consensus of opinion amongst these teachers, who have had much greater experience than can be claimed by any body of graduates, in favour of the proposed changes. The Royal Commission have impartially considered the views of those who are in favour of the scheme and of those who are opposed to it, and they have arrived at the conclusion that the scheme is one which is likely to be of public advantage and will be detrimental to no one. I only desire further to remark that I think that the scheme of the Cowper Commission, although on the whole an admirable one, is susceptible of improvement in its details, leaving its general principles untouched. The very object of appointing the Statutory Commission is to carry out those recommendations, and that the details should be looked at by a body of able men, and that the weight and force of the objections raised to those details should be fully considered and, where necessary, modified. I know that some of the opponents of the present scheme desire to create another University in London alongside of the University of London. That is a question that has been considered by men of great weight and authority, who have very largely pronounced against the proposal. The House of Commons has emphatically pronounced against it, and I believe that the country has also pronounced against it in an equally emphatic manner. Under these circumstances, I believe the best hope for the solution of this question and for the increase, even, of the valuable work which the University of London has done, lies in the direction proposed by the noble Duke.

Earl Cowper, speaking as chairman of the Commission that considered this question, said that when the work of that body first began he was prepossessed in favour of the Gresham scheme, because he thought everybody would admit that, if there was to be a second University, that scheme would have been at least as good as any other which could have been devised. But he found that the large majority of his fellow Commissioners were of a contrary opinion, and as the evidence proceeded he became more and more convinced that the great bulk of opinion throughout the country, and more particularly in the metropolis, was not in favour of a second University, but in favour of one. He could not help feeling pretty sure that everybody who went through the voluminous mass of evidence would gradually come to the same conclusion as that at which he had arrived.

Lord Playfair said that he introduced a Bill last year for the purpose of converting the present London University into a teaching University, and as the noble Duke had accepted the Bill he would strongly urge that the Government should take the matter up in earnest, considering the enormous amount of support which they now had in regard to the scheme. This scheme had been under the consideration of educationists for a whole generation. Three times the Convocation of the existing London University had met and discussed the principles of this Bill, and by increasing and finally by an overwhelming majority had pronounced in their favour. The minority of the Convocation, and individual graduates in the country, refused to accept their defeat, and were still alarmed at the proposed changes in the constitution of the present University. At the basis of their opposition was the fear that the new University might lower the value of degrees, and thus lessen the honour in which the existing graduates were now held. This fear did not seem to be shared to any extent by graduates who had the highest degrees. They had never had it explained why an organised teaching University should think it to their interest to lower the value of the degrees. One would say that their interest was to keep up the degrees to the highest value, and he thought the graduates, when they considered the question, would gradually come to this view. London was the only large town—he would not say the only capital—which did not possess an organised teaching University. It was a most melancholy fact—a fact that was a disgrace to the metropolis, that, although the towns of great population possessed organised teaching Universities, the London University did not yet do so. It was impossible that the London University, with its present powers and its present charters, could constitute a teaching University in accord with the science of the time. Teaching by verbalism was more and more going out in science. Lecturers were of far less importance than experimental work in laboratories. For this purpose well-equipped colleges were absolutely necessary, and the object of the University would be to raise itself continually up to the level of science. The object of this scheme, for which educationists had been agitating for so many years, was to produce this result. The Bill would provide a system of education capable of raising itself continually to the heightening and advancing state of knowledge. It did not provide the means, however; but if they erected an organised University of which Londoners and the people of this country would be proud, he was perfectly sure that the funds would not be lacking. He would give one instance of why they should have that confidence. The late Royal Commission appointed a small committee, consisting of Prof. Burdon-Sanderson and himself, to consider the scientific part of the report; and they recommended the foundation of research laboratories for chemistry and physics, independent of the existing colleges, but open to any of the graduates who showed the power of advancing the boundaries of science by original researches. Their recommendation was adopted after some hesitation on the part of their colleagues, because they thought they were asking too much, for no funds were in view for building and equipping such laboratories or for maintaining them when equipped. The generosity of one scientific manufacturer —Mr. Mond—had already founded these laboratories, which two years ago looked so hopeless of accomplishment. Like results would follow in regard to other recommendations of the Commission. He would like to point out how important it was that a large community like that should put itself into the position of having organised University teaching as other places had. They were doing nothing in this country at the present moment compared with what was being done in other countries for the promotion of higher University education. After the Franco-German war the French Institute had a most interesting discussion upon the question, "Why did our late crisis produce no great people in this country?" and the universal feeling in the Institute was that France had not sufficiently attended to her higher University education. Renan, in summing up the whole debate, said:—"It is German science that won the day at Sadowa and Sedan. The German national spirit is a product of the German Universities, and the German Fatherland is a product of that spirit." Inspired by these views France, since the war, had spent nearly 100 millions of francs in equipping her higher colleges, so that they might suffice for modern scientific requirements; and it now spent annually about as much as Germany in higher education. Germany had not stood still. When she acquired Strasburg as a result of the war, she spent upon that small town no less than £711,000 sterling in the building of a new University and its scientific laboratories, and annually voted above £50,000 sterling for their maintenance. The future competitions of the world would not be determined by armies and navies alone, but would be mainly governed by the intellectual development of the people. In the presence of these facts, surely England could not allow its great capital to remain the only large town, either in the United Kingdom or abroad, which had no means by which organised University teaching could be given to her people.

Lord Reay said that the main purpose of the Bill was to put an end to an anomaly. London had a variety of institutions in which University education was given, but which had not the power of conferring degrees; and, on the other hand, London had an examining Board unconnected with the teaching institutions. The institutions had no crown to their edifice; the University had no foundation. The object of the scheme of the last Royal Commission was to constitute a corporate body out of these scattered fragments, and recognition was given on well-defined and broad lines to University teaching wherever it existed. The aim of the Bill was not merely educational. It had a much wider bearing. What was the cause of the increased expenditure on higher education on the continent? It was the consciousness that wealth and military power were insufficient; that higher education must provide the intellectual capital which agriculture, industry, and trade required. If we were to hold our own in this race we must use the same means. A London University would not be a mere local institution; it would eventually be an Imperial institution, profiting all classes throughout the Empire. The progress of the Bill was anxiously watched by scientific men at home as well as abroad. There was, indeed, practical unanimity among all those who had the higher interests of the country at heart that failure to give London a teaching University would be nothing less than a national disgrace.

Lord Kelvin felt that the reasons already put before their lordships for accepting the Bill were overwhelmingly strong, and he only wished to intervene because he had been mentioned as one apparently partially opposed to the provisions of the Bill. As a member of Lord Cowper's Commission he joined with Sir George Stokes and Mr. Weldon in a note expressing a preference for a separate teaching University. They had some doubts as to whether or not the functions of a teaching University could practically be added to the duties so well performed by the University of London of examining for degrees and conferring degrees upon students who had not had the benefit of instruction in colleges of universities in any part of the world. They felt the gravity of the objection that might be held to establishing another university—a rival university—beside the University of London; but when it seemed, as it did then seem to them, hopeless that the University of London could be got to undertake the duty of organising and carrying on a teaching University, they felt that the paramount object of having a teaching University in London should not on that account be given it. On his own behalf, and, he believed, on behalf of his colleagues in the note, he could say they would only have been too glad to have accepted what was now proposed by this Bill. Their doubts and hesitation had been completely set aside by what had passed. Personally he thoroughly approved of the Bill. He believed that an immense addition to the usefulness of the existing colleges in London would result from the passing of the measure. It was an anomalous state of things that there was no teaching University in London. It was not only London, but the United Kingdom, and, indeed, the whole world, that would benefit by the passing of the Bill, and therefore his desire was strong and evident, not only that the Bill might pass speedily through their lordships' House, but that it would be taken up by the House of Commons and made an Act of Parliament before the close of the present Session.

The Earl of Kimberley said that some years ago he had the honour to be President of University College, and at that time there was put forward a scheme for a separate University such as Lord Kelvin thought might be the only alternative. He then felt it would be a great misfortune if there were set up two rival universities in London, and therefore, he need hardly say, how greatly he rejoiced that they had arrived at last at a point where they seemed to have in view a conjunction of teaching and examining in the University of London. He was glad to see the noble Duke had inserted in the Bill the clause that the Commissioners were to see that provision was made for securing adequately the interests of collegiate and non-collegiate students respectively. That ought to reassure those who had placed themselves in opposition to the Bill, because an impartial Statutory Commission such as the noble Duke intended to appoint would be perfectly able to see that the statutes of the University were so framed that there would be no chance of any portion of the University work being impaired by a wrong administration of its powers.

The second reading was then agreed to.

SCIENCE FOR SECONDARY SCHOOLS.

THE Reports of the United States Commissioner of Education are known to be the most valuable publications on educational statistics and methods in the English language. The Report (1892–93), just distributed, may appear to be somewhat belated, but the contents are so instructive and exhibit so many special features, that the delay of publication may be forgiven. There are two volumes, running altogether into 2153 pages, and the amount of information contained in them is marvellous. Taking the volumes in order, we find in the first elaborate tables of statistics referring to the schools of the United States, and statistics of illiteracy for each of the States and for Europe. Then follow surveys of the educational system of Belgium, the elementary schools of Great Britain, the systems of education developed in the British Colonies, the French educational system, and a most instructive chapter on developments in the teaching of geography in Central Europe. The chapter on child-study, which practically concludes Part I. of the first volume, contains a number of interesting contributions from leading American representatives of this modern movement.

The second part of the first volume is devoted entirely to reports which were called forth on the occasion of the World's Columbian Exposition. Among these reports are detailed criticisms of American educational methods, by eminent French and German educationists. There is a survey of medical instruction in the United States, as presented in the reports of two French Commissioners appointed to make a special study of the subject, and an English version of a report on American technological schools, prepared by Prof. Riedler, of the Royal Polytechnicum at Charlottenberg. The remainder of the first volume is taken up with papers read at the Library Congress held during the Columbian Exposition, and notes on the educational exhibits.

The second volume contains the third and fourth parts of the Report. Prof. Hinsdale contributes to it a series of rare documents illustrative of American educational history, and there is incorporated in it the report of the Committee of Ten, appointed to take up the important subject of courses of instruction in secondary schools, and papers relating thereto. The chief interest for us in the volume lies in this valuable educational document.

The Committee, which was appointed by the National Council of Education, organised conferences of leading teachers of the principal subjects which enter into the programmes of secondary schools in the United States. Each of nine subjects was considered and reported upon by a conference consisting of ten members, who were selected on account of their scholarship and experience. Among the subjects discussed were four concerned with groups of sciences; viz. (1) mathematics; (2) physics, astronomy, and chemistry; (3) natural history (biology, including botany, zoology, and physiology); (4) geography (physical geography, geology, and meteorology). As a result of the conferences, a great number and variety of important changes in the scope and method of science teaching were recommended. All the conferences on scientific subjects agreed that laboratory work by the pupils was the best means of instruction, and dwelt upon the great utility of the genuine laboratory note-book; and they all declared that teachers of science in schools need at least as thorough a special training as teachers of languages or mathematics receive.

The most important recommendations made by the scientific conferences are summarised in the following pages. But all who are interested in scientific education should read the entire reports, for each is so full of suggestions and recommendations, that it is impossible to present adequate abstracts of them.

On one very important question of general policy, which affects the preparation of all school programmes, the Committee of ten, and all the conferences organised by it, were absolutely unanimous. Among the questions suggested for discussion in each conference was—"Should the subject be treated differently for pupils who are going to college, for those who are going to a scientific school, and for those who, presumably, are going to neither?" This question was answered unanimously in the negative by all the conferences; so that we have the fact that nearly one hundred eminent teachers agree that every subject which is taught at all in a secondary school should be taught in the same way and to the same extent to every pupil so long as he pursues it, no matter what the probable destination of the pupil may be, or at what point his education is to cease.

MATHEMATICS.

The form of the report of the conference on mathematics differs somewhat from that of the other reports. This report is subdivided under five headings: (1) General conclusions; (2) the teaching of arithmetic; (3) the teaching of concrete geometry; (4) the teaching of algebra; (5) the teaching of formal or demonstrative geometry.

The first general conclusion of the conference was arrived at unanimously. The conference consisted of one Government official and university professor, five professors of mathematics in as many colleges, one principal of a high school, two teachers of mathematics in endowed schools, and one proprietor of a private school for boys. The professional experience of these gentlemen and their several fields of work were various, and they came from widely separated parts of America; yet they were unanimously of opinion "that a radical change in the teaching of arithmetic was necessary." They recommend "that the course in arithmetic be at once abridged and enriched; abridged by omitting entirely those subjects which perplex and exhaust the pupil without affording any really valuable mental discipline, and enriched by a greater number of exercises in simple calculation, and in the solution of concrete problems." They specify in detail the subjects which they think should be curtailed or entirely omitted, and they give in their special report on the teaching of arithmetic a full statement of the reasons on which their conclusion is based. They map out a course in arithmetic which, in their judgment, should begin about the age of six years, and be completed at about the thirteenth year of age.

The conference next recommend that a course of instruction in concrete geometry with numerous exercises be introduced into the grammar schools, and that this instruction should, during the earlier years, be given in connection with drawing. They recommend that the study of systematic algebra should be begun at the age of fourteen; but that, in connection with the study of arithmetic, the pupils should earlier be made familiar with algebraic expressions and symbols, including the method of solving simple equations. "The conference believe that the study of demonstrative geometry should begin at the end of the first year's study of algebra, and be carried on by the side of algebra for the next two years, occupying about two hours and a half a week." They are also of opinion "that if the introductory course in concrete geometry has been well taught, both plane and solid geometry can be mastered at this time." Most of the improvements in teaching arithmetic which the conference suggest "can be summed up under the two heads of giving the teacher a more concrete form, and paying more attention to facility and correctness in work. The concrete system should not be confined to principles, but be extended to practical applications in measuring and in physics."

In regard to the teaching of concrete geometry, the conference urge that while the student's geometrical education should begin in the kindergarten, or at the latest in the primary school, systematic instruction in concrete or experimental geometry should begin at about the age of ten for the average student, and should occupy about one school hour a week for at least three years. From the outset of this course, the pupil should be required to express himself verbally as well as by drawing and modelling. He should learn to estimate by the eye, and to measure with some degree of accuracy lengths, angular magnitudes, and areas; to make accurate plans from his own measurements and estimates; and to make models of simple geometrical solids. The whole work in concrete geometry will connect itself on the one side with the work in arithmetic, and on the other with elementary instruction in physics. With the study of arithmetic is therefore to be intimately associated the study of algebraic signs and forms, of concrete geometry, and of elementary physics. Here is a striking instance of the interlacing of subjects which seems so desirable to every one of the conferences.

Under the head of teaching algebra, the conference set forth in detail the method of familiarising the pupil with the use of algebraic language during the study of arithmetic. This part of the report also deals clearly with the question of the time required for the thorough mastery of algebra through quadratic equations. The report on the teaching of demonstrative geometry is a clear and concise statement of the best method of teaching this subject. It insists on the importance of elegance and finish in geometrical demonstration, for the reason that the discipline for which geometrical demonstration is to be chiefly prized is a discipline in complete, exact, and logical statement. If slovenliness of expression, or awkwardness of form is tolerated, this admirable discipline is lost. The conference therefore recommend an abundance of oral exercises in geometry—for which there is no proper substitute—and the rejection of all demonstrations which are not exact and formally perfect. Indeed, throughout all the teaching of mathematics the conference deem it important that great stress be laid by the teacher on accuracy of statement and elegance of form as well as on clear and rigorous reasoning. Another very important recommendation in this part of the report is to be found in the following passage: "As soon as the student has acquired the art of rigorous demonstration, his work should cease to be merely receptive. He should begin to devise constructions and demonstrations for himself. Geometry can not be mastered by reading the demonstrations of a text-book, and while there is no branch of elementary mathematics in which purely receptive work, if continued too long, may lose its interest more completely, there is also none in which independent work can be made more attractive and stimulating." These observations are entirely in accordance with the recent practice of some colleges in setting admission examination papers in geometry which demand of the candidates some capacity to solve new problems, or rather to make new application of familiar principles.

PHYSICS, CHEMISTRY, AND ASTRONOMY.

The members of this conference were urgent that the study of simple natural phenomena be introduced into elementary schools, and it was the sense of the conference that at least one period a day from the first year of the primary school should be given to such study. Apparently the conference entertained the opinion that the present teachers in elementary schools are ill prepared to teach children how to observe simple natural phenomena; for their second recommendation was that special science teachers or superintendents be appointed to instruct the teachers of elementary schools in the methods of teaching natural phenomena. The conference were clearly of opinion that from the beginning this study should be pursued by the pupil chiefly, though not exclusively, by means of experiments and by practice in the use of simple instruments for making physical measurements. The report dwells repeatedly on the importance of the study of things and phenomena by direct contact. It emphasises the necessity of a large proportion of laboratory work in the study of physics and chemistry, and advocates the keeping of laboratory note-books by the pupils, and the use of such note-books as part of the test for admission to college. At the same time the report points out that laboratory work must be conjoined with the study of a text-book and with attendance at lectures or demonstrations, and that intelligent direction by a good teacher is as necessary in a laboratory as it is in the ordinary recitation or lecture room.

The great utility of the laboratory note-book is emphatically stated. To the objection that the kind of instruction described requires much time and effort on the part of the teacher, the conference reply that to give good instruction in the sciences requires of the teacher more work than to give good instruction in mathematics or the languages; and that the sooner this fact is recognised by those who have the management of schools the better for all concerned. The science teacher must regularly spend much time in collecting materials, preparing experiments, and keeping collections in order, and this indispensable labour should be allowed for in programmes and salaries. As regards the means of testing the progress of the pupils in physics and chemistry, the conference were unanimously of opinion that a laboratory examination should always be combined with an oral or written examination, neither test taken singly being sufficient. There was a difference of opinion in the conference on the question whether physics should precede chemistry, or chemistry physics. The logical order would place physics first; but all the members of the conference but one advised that chemistry be put first for practical reasons which are stated in the majority report. A sub-committee of the conference has prepared lists of experiments in physics and chemistry for the use of secondary schools, not, of course, as a prescription, but only as a suggestion, and a somewhat precise indication of the topics which the conference had in mind, and of the limits of the instruction.

NATURAL HISTORY.

The conference on natural history unanimously agreed that the study of botany and zoology ought to be introduced into the primary schools at the very beginning of the school course, and be pursued steadily, with not less than two periods a week,

throughout the whole course below the high school. In the next place, they agreed that in these early lessons in natural science no text book should be used; but that the study should constantly be associated with the study of literature, language, and drawing. It was their opinion that the study of physiology should be postponed to the later years of the high school course; but that in the high school, some branch of natural history proper should be pursued every day throughout at least one year. Like the report on physics, chemistry, and astronomy, the report on natural history emphasises the absolute necessity of laboratory work by the pupils on plants and animals, and would have careful drawing insisted on from the beginning of the instruction.

As the laboratory note-book is recommended by the conference on physics, so the conference on natural history recommends that the pupils should be made to express themselves clearly and exactly in words, or by drawings, in describing the objects which they observe; and they believe that this practice will be found a valuable aid in training the pupils in the art of expression. They agree with the conference on physics, chemistry, and astronomy that science examinations should include both a written and a laboratory test, and that the laboratory note-books of the pupils should be produced at the examination. The recommendations of this conference are therefore very similar to those of the physical conference, so far as methods go; but there are appended to the general report of the conference on natural history sub-reports which describe the proper topics, the best order of topics, and the right methods of instruction in botany for schools below the high school, and for the high school itself, and in zoology for the secondary schools. Inasmuch as both the subject-matter and the methods of instruction in natural history are much less familiar to ordinary school teachers than the matter and the methods in the languages and mathematics, the conference believed that descriptive details were necessary in order to give a clear view of the intentions of the conference. In another sub-report the conference give their reasons for recommending the postponement to the latest possible time of the study of physiology and hygiene. Like the sixth conference, the conference on natural history protest that no person should be regarded as qualified to teach natural science who has not had special training for this work—a preparation at least as thorough as that of their fellow teachers of mathematics and the languages.

GEOGRAPHY.

Considering that geography has been a subject of recognised value in elementary schools for many generations, and that a considerable portion of the whole school-time of children has long been devoted to a study called by this name, it is somewhat startling to find that the report of the conference on geography deals with more novelties than any other report, exhibits more dissatisfaction with prevailing methods, and makes, on the whole, the most revolutionary suggestions.

It is obvious, on even a cursory reading of the majority and minority reports, that geography means for all the members of this conference something entirely different from the term "geography" as generally used in school programmes. Their definition of the word makes it embrace not only a description of the surface of the earth, but also the elements of botany, zoology, astronomy, and meteorology, as well as many considerations pertaining to commerce, government, and ethnology. "The physical environment of man" expresses as well as any single phrase can the conference's conception of the principal subject which they wish to have taught. No one can read the reports without perceiving that the advanced instruction in geography which the conference conceive to be desirable and feasible in high schools cannot be given until the pupils have mastered many of the elementary facts of botany, zoology, geometry, and physics. It is noteworthy also that this conference dealt avowedly and unreservedly with the whole range of instruction in primary and secondary schools. They did not pretend to treat chiefly instruction in secondary schools, and incidentally instruction in the lower schools; but, on the contrary, grasped at once the whole problem, and described the topics, methods, and apparatus appropriate to the entire course of twelve years. They recognised that complete descriptions would be necessary in all three branches of the subject—topics, methods, and equipment; and they have given these descriptions with an amplitude and force which leave little to be desired.

More distinctly than any other conference, they recognised that they were presenting an ideal course which could not be carried into effect everywhere or immediately. Indeed, at several points they frankly state that the means of carrying out their recommendations are not at present readily accessible, and they exhibit the same anxiety which is felt by several other conferences about training teachers for the kind of work which the conference believe to be desirable. After the full and interesting descriptions of the relations and divisions of geographical science, as the conference define it, the most important sections of their report relate to the methods and means of presenting the subject in schools, and to the right order in developing it. The methods which they advocate require not only better equipped teachers, but better means of illustrating geographical facts in the schoolroom, such as charts, maps, globes, photographs, models, lantern slides, and lanterns. Like all the other conferences on scientific subjects, the ninth conference dwell on the importance of forming from the start good habits of observing correctly and stating accurately the facts observed. They also wish that the instruction in geography may be connected with the instruction in drawing, history, and English. They believe that meteorology may be taught as an observational study in the earliest years of the grammar school, the scholars being even then made familiar with the use of the thermometer, the wind vane, and the rain gauge; and that it may be carried much further in the high school years, after physics has been studied, so that the pupils may then attain a general understanding of topographical maps, of pressure and wind charts, of isothermal charts, and of such complicated subjects as weather prediction, rainfall and the distribution of rain, storms, and the seasonal variations of the atmosphere.

Their conception of physiography is a very comprehensive one. In short, they recommend a study of physical geography which would embrace in its scope the elements of half a dozen natural sciences, and would bind together in one sheaf the various gleanings which the pupils would have gathered from widely separated fields. There can be no doubt that the study would be interesting, informing, and developing, or that it would be difficult and in every sense substantial.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

PROF. G. B. MATHEWS has resigned the chair of Mathematics in the University College of North Wales, in order to be able to devote more time to study and research.

THE Executive Committee of the City and Guilds of London Institute have appointed Mr. W. E. Dalby, since 1891 University Demonstrator of Mechanism and Applied Mechanics at Cambridge, to the Professorship of Mechanics and Applied Mathematics at the Institute's Technical College, Finsbury, rendered vacant by the resignation of Prof. Perry.

Science reports the dedication, at the University of Vermont, of two new buildings—Converse Hall, a dormitory presented to the University by John H. Converse at a cost of £25,000; and a science building presented by Dr. Edward H. Williams, which, with its equipment, will cost about £40,000. The dormitory was formally presented to the University by Mr. Converse; and the science building, in the absence of Dr. Williams, by his son, Prof. Edward H. Williams, jun., of Lehigh University. On the front of the latter building are three medallions with the heads of Agassiz, Henry, and Prof. Marsh. The building contains ample accommodation for the departments of physics, chemistry, biology, electrical engineering, and metallurgy.

EARL SPENCER, in distributing the prizes on Monday to the successful pupils at Northampton School, spoke of the absolute necessity of a sound primary education for a sound secondary technical and even University education. In Japan, and in Canada, too, he found that both secondary and University education were secured to the people. The fact that England should be behind was rather curious, and he took it that a great deal of it was due to the old grammar schools and the dislike of Parliament, with these schools existing, to create a national system of secondary education in England. That more secondary and University education was required was illustrated by the fact that, while Germany, with a population of 45,000,000, had 24,000 people using her Universities, England, with 30,000,000, had only 5500 at the University.

WE learn from *Science* that a State Veterinary College has been established in New York. It is pointed out that the animal industry of the State is so important and extensive, and the relations of animal diseases so intimately interwoven with human health and well-being, that the financial and sanitary interests of the State will derive benefit from the knowledge and continued investigations of the body of experts which the College will bring together. The following have already been appointed upon the staff of the College:—Director and Professor of Veterinary Medicine, Principles and Practice, Zymotic Diseases, and State Medicine, Dr. James Law; Professor of Veterinary and Comparative Pathology and Bacteriology, Dr. V. A. Moore; Assistant Professor of Veterinary and Comparative Physiology, Materia Medica and Pharmacy, Dr. P. A. Fish; Assistant Professor of Veterinary Anatomy and Anatomical Methods, Dr. G. S. Hopkins; Professor of Microscopical Technology, Histology and Embryology, S. H. Gage; Instructor in Microscopy, Histology and Embryology, Dr. B. F. Kingsbury; Assistant in Veterinary Bacteriology, Dr. R. C. Reed.

SCIENTIFIC SERIALS.

Wiedemann's Annalen der Physik und Chemie, No. 7.—Polarised fluorescence, by L. Sohncke. The polarisation of fluorescent light is capable of giving hints concerning the manner in which the molecules of a solid substance vibrate, and its study may form the basis of the kinetic theory of solids. Theoretically, all doubly-refracting crystals should emit polarised fluorescence. This is found to be the case. Crystals of the regular system are the only crystals which do not. The author has investigated the fluorescence of a large number of substances in confirmation of this view.—Uniformities in the spectra of solid bodies, by F. Paschen. The author investigates the distribution of energy in the spectrum of glowing iron oxide at various temperatures. Of the formula hitherto proposed for its expression, that of Weber most closely approaches the reality. It gives a nearly parabolic curve in which the energy declines on both sides from a maximum which decreases in wave-length as the temperature rises. But the want of symmetry in Weber's curve is greater than in reality. The author finds a new formula, for which he claims that it covers all the observations.—The electrical behaviour of vapours from electrified liquids, by G. Schwalbe. The author finds that the vapours rising from electrified liquids are not capable of bearing away with them any portion of the electric charge, and that Exner's theory of atmospheric electricity must therefore be abandoned.—The damping action of magnetic fields upon rotating insulators, by William Duane. Cylinders and discs of glass, sulphur, paraffin, ebonite, or quartz, oscillating between the poles of a magnet with their axes vertical and at right angles to the lines of force, experience a damping action proportional to the field intensity and to the speed of rotation. This is not due to an action on the suspending threads, nor on the viscosity of the air, nor an electrostratic effect from the current in the coils, nor to induction currents in the substance, as was proved by test experiments and calculations. It must therefore be regarded as a hitherto unobserved magnetic effect upon the insulators in question.—Effect of magnetism upon electromotive force, by A. H. Bucherer. The author finds that in solutions of neutral ferrous salts no E.M.F. exceeding 0·00001 volt can be produced by the magnetisation of one of the two iron electrodes. The E.M.F.s observed by Gross and others must be attributed to changes of concentration produced by the magnetised electrode during its solution.—On the measurement of flame temperatures by thermo-elements, especially the temperature of the Bunsen burner, by W. J. Waggener. The temperatures were determined by various thermo-couples in different parts of the flame. The highest temperature, 1700° C., was indicated in the lower portion of the external mantle. But an infinitely thin thermo-element free from conduction would probably indicate over 1770°. A wire 0·05 mm. thick still suffers from conduction, and it is actually fused in the hottest portion. A more refractory metal is required for these measurements.

Bollettino della Società Sismologica Italiana, vol. ii., 1896, No. 1.—Velocity of propagation of the Paramythia (Epirus) earthquake of the night of May 13-14, 1895, by Dr. G. Agamennone. From time-observations obtained at several places near the epicentre, at six Italian observatories and at Nicolaiew, it appears that the early tremors travelled with a velocity of 1·94 km. per sec., and the oscillations constituting the maximum phase at the rate of 1·42 km. per sec. There is no evidence of any change in the velocity with the distance from the epicentre.—Vesuvian notes (July–December 1895), by Prof. G. Mercalli.

THE last number of the *Izvestia* of the Russian Geographical Society (1895, vi.) contains a new map of Lake Onega, in which last year's measurements of the depths of the lake are embodied. The greatest depths are in its western part, where they attain from 31 to 68 fathoms. This last depth is reached in the branch by which the lake protrudes towards the north-west. A narrow valley is thus formed at its bottom, and runs north-west to south-east, in the direction of the glacial striation in that region. Another great depth is found at the top of the other fjord-like bay in the northern portion of the lake, also directed to the north-west.

WE find in the last numbers of the *Izvestia* of the East-Siberian branch of the Russian Geographical Society (1895, Nos. 1 to 5) a very good sketch of the Yakutes of Verkhoyansk, by S. Kovalik; and an interesting note on the little-known customary hunting laws of the Buryates, by M. Croll; as also a full translation, from the Mongolian, of the renowned Buddhist "Mirror of Wisdom," which gives the "History of the Kingdom of Sukawadi."—M. Prein's preliminary article on the presence of the lime-tree in the neighbourhood of Krasnoyarsk is especially interesting. It is known that that tree does not appear to the east of the Urals, and only reappears in the Amur region on the very slopes of the high central plateau. But it was lately found in the Kuznetsk Alatau mountains, and has now been discovered further to the north-east, in the neighbourhood of Krasnoyarsk.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 18.—"Magnetisation of Liquids." By John S. Townsend.

The experiments on the coefficient of magnetisation of liquids were made with a sensitive induction balance. Both circuits were commuted about sixteen times a second, so that very small inductances could be detected by the galvanometer in the secondary circuit. The principle of the method consisted in balancing the increase of the mutual induction of the primary on the secondary of a solenoid arising from the presence of a liquid in the solenoid against known small inductances. Thus, if the sum of the inductances be reduced to zero, as shown by the galvanometer in the secondary giving no deflection, the balance will be disturbed to the extent $4\pi k\mathrm{M}$, due to the insertion of a liquid into the solenoid whose coefficient of magnetisation is k, and the galvanometer in the secondary circuit will give a deflection when the commutator revolves. An adjustable inductance is then reduced by a known amount, m, till the deflection disappears; so that we get

$$4\pi k\mathrm{M} = m \qquad \therefore k = m/4\pi\mathrm{M},$$

where m and M are quantities easily calculated.

Since the formula does not contain either the rate of the rotation of the commutator or the value of the primary current, no particular precautions are necessary to keep these quantities constant.

In all the determinations the magnetising force was varied from 1 to 9 centigram units, and in no case was there any variation in k. The densities of the salts in solution were also varied over large ranges, and showed that the coefficient of magnetisation for ferric salts in solution depended only on the quantity of iron per c.c. that was present, giving the formula

$$10^7 k = 2660\,\mathrm{W} - 7·7$$

for ferric salts, where W is the weight of iron per c.c., the quantity $-7·7$ arising from the diamagnetism of the water of solution.

A similar result was obtained for ferrous salts, the corresponding formula being

$$10^7 k = 2060\,\mathrm{W} - 7·7,$$

the temperature being 10° C.

Experiments were also performed to find the effect of heating,

and they showed a great diminution in the value of k as the temperature increased, thus letting $k = k_0 (1 - \alpha t)$ the coefficient α is the same for ferrous and ferric salts, being a function of the temperature only, its value at the lower temperatures between 5° and 25° C. being about ·0055, and at the higher temperatures between 65° and 75° C. its value is ·0035.

Paris.

Academy of Sciences, July 20.—M. A. Chatin in the chair.—Laws of uniform flow to the second approximation in circular tubes and in semicircular canals, by M. J. Boussinesq. A continuation of previous papers on the same subject.—Study of lanthanum carbide, by M. H. Moissan. This carbide, which is obtained from the oxide and carbon in the usual manner, forms a transparent yellowish crystalline mass, of the composition LaC_2. Water rapidly decomposes it at the ordinary temperature, giving acetylene, ethylene, and methane, with traces of solid and liquid hydrocarbons.—The relations between the expenditure of energy of a muscle and the amount of shortening it undergoes, by M. A. Chauveau. The method of the respiratory exchanges was used in this as in previous work on the same subject. For a given amount of external work done by the muscle, the energy used up is smaller as the muscle is nearer to its maximum length.—Report on a memoir of M. Jäderin, concerning a new method of measuring a base line, by M. Bassot. By the substitution of wires for steel tape, there is a gain in speed and also in the initial expense. The results obtained in working over well-established base lines, although agreeing amongst themselves to 1/100,000, disagree by 1/25,000 from the mean results of other methods.—Mirages and refractions observed on Lake Leman, by M. F. A. Forel.—On the photography of the sounds of the heart, by M. A. de Holowinski. The sounds are transmitted by a sensitive microphone to an optical telephone, the diaphragm of which produces Newton's rings, which are photographed.—On a new method of treating tuberculosis, by M. Fr. Crótte.—The Secretary announced the death of M. A. Kékulé von Stradonitz, Correspondent in the Section of Chemistry, on July 13.—On the summations of Gauss, by M. P. de Séguier.—On the definite quadratic forms of M. Hermite, by M. Alfred Lœwy.—On an electroscope with three gold leaves, by M. L. Benoist. The instrument described has the advantages of increased sensibility and greater certainty in the measurement of the angle of deflection.—On metallic alloys, by M. H. Gautier. Giving fusibility curves for cadmium-silver, zinc-silver, and tin-silver alloys.—On the oxygen salts of mercury, by H. Raoul Varet. A thermochemical study of the condition of some mercuric salts on solution in dilute acids.—On the action of the halogen compounds of phosphorus upon iron, nickel, and cobalt, by M. A. Granger. The phosphides Fe_4P_3, Ni_2P, and Co_2P, together with the chlorides, were obtained.—On some combinations of iodic acid with other acids, by M. Paul Chrétien. An account of the salts of molybdo-iodic, metatungsto-iodic, and phospho-iodic acids.—Action of ammonia upon the paratungstates of potash and soda, by M. L. A. Hallopeau.—Action of reducing agents upon the nitroso-compounds of osmium, by M. L. Brizard. By the reduction of $Os.(NO).OK$ in acid solution with stannous chloride an amido-compound, $Os.(NH_2).Cl_3.KCl$, is obtained.—Fermentation of uric acid by micro-organisms, by M. E. Gérard. Under certain conditions it is possible to split up uric acid in such a manner that the whole of the nitrogen appears as urea, no ammonia being formed.—Action of the chloride of sulphur upon penta-erythrite, by M. J. Bougault. A chlorhydrin and sulphurous ether are formed simultaneously.—On the determination of the freezing-point of dilute aqueous solutions, by M. A. Ponsot. A discussion of the correction recently proposed by M. Raoult.—Estimation of alcohol in the blood after direct injection into the veins, or the introduction of alcoholic vapour into the lungs, by M. N. Gréhant.—Coagulating action of the prostatic fluid upon the contents of the seminal vesicles, by MM. L. Camus and E. Gley.—The influence of lecithine upon the growth of warm-blooded animals, by M. B. Danilewsky. The injection of lecithine in small quantities causes an acceleration in growth.—On the dorsal apodeme of the Araneida, by M. Causard.—On the tubercle disease of the vine, by M. F. Lataste. The tubercles are shown to be very contagious. It is necessary to destroy by fire all infected stocks to stamp out the disease.—Direct estimation of ethyl alcohol in solutions where it is diluted in proportions between 1/500th and 1/3000th, by M. Maurice Nicloux.

Philadelphia.

Academy of Natural Sciences, June 16.—The following papers were presented for publication:—"On a collection of fishes obtained in Swatow, China, by Miss Adele M. Fielde," by Cloudesley Rutter; "On a collection of fishes made by the Rev. Jos. Seed Roberts in Kingston, Jamaica," by David Starr Jordan and Cloudesley Rutter.—Prof. Edward D. Cope continued his report on the vertebrate remains from the Port Kennedy bone-fissure. Among the Mustellidæ were five new species of the genera Lutra, Mephitis, Osmotherium, and Putorius. They were represented by at least forty individuals, and were described and named. Remains of the largest known tortoise from this section of the country were described as belonging to a new species of Clemmys. *C. insculpta* was also represented, together with a new box-tortoise belonging to the genus Toxaspis. A close ally of the black snake was also described.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Catalogue of the Fossil Bryozoa in the Department of Geology, British Museum (Natural History). The Jurassic Bryozoa: Dr. J. W. Gregory (London).—Annuario p.p. Observatorio do Rio de Janeiro, 1896 (Rio de Janeiro).—Report on the Work of the Horn Scientific Expedition to Central Australia. Part 3. Geology and Botany (Dulau).—Practical Mechanics applied to the Requirements of the Sailor: T. Mackenzie (Griffin).—Handbuch der Gewebelehre des Menschen: Prof. A. Koelliker, Sechste Umgearbeitete Auflage, Band 1 and 2 (Leipzig, Engelmann).—Everybody's Guide to Chess and Draughts: H. Peachey (Saxon).—Everybody's Cycling Law: S. Wright and C. W. Browne (Saxon).—Erkenntnistheoretische Grundzüge der Naturwissenschaften, &c.: Dr. P. Volkmann (Leipzig, Teubner).—Three Essays on Australian Weather: Hon. R. Abercromby (Sydney, White).—Essai de Paléontologie Philosophique: Prof. A. Gaudry (Paris, Masson).—Die Mikrotechnik der Thierischen Morphologie: Dr. S. Apáthy, Erste Abthg. (Braunschweig, Bruhn).

Pamphlets.—American Museum of Natural History, Annual Report, 1895 (New York).—History of Modern Mathematics: Prof. D. E. Smith (Chapman).—The X-Rays: A. Thornton (Lund).—Das Parallelogramm der Kräfte: Dr. J. Sperber (Zürich, Speidel).

Serials.—Lloyd's Natural History. Butterflies: W. F. Kirby. Part 3 (Lloyd).—Proceedings of the Academy of Natural Sciences of Philadelphia, 1896, Part 1 (Philadelphia).—Royal Natural History, Part 33 (Warne).—History of Mankind: F. Ratzel, translated, Part 10 (Macmillan).—Himmel und Erde, July (Berlin, Paetel).—American Journal of Psychology, Vol. 7, No. 4 (Worcester, Mass.).

CONTENTS.

THURSDAY, AUGUST 6, 1896.

TRAVELS IN EASTERN AFRICA.

Through Jungle and Desert. Travels in Eastern Africa. By William Astor Chanler, A.M. (Harv.), F.R.C.S. 8vo. Pp. xiv + 535. With 85 illustrations and 2 maps. (London: Macmillan and Co., Ltd., 1896.)

BRITISH East Africa and the adjoining parts of Africa, which are included in the spheres of influence of Germany and Italy, consist of a series of zones which run approximately parallel to the coast. Along the shore of the Indian Ocean is the low narrow coastal plain. In the interior are the high grass plains of Masailand, the dense forests and plantations of Kikuyu and Mau, and the thickly populated and well-watered basin of the Nyanza. Between these fertile zones lies a broad tract of barren, sandy, scrub-covered plains, occupied only by herds of game which follow the rains across it, or by small colonies of people who live along the banks of the rivers, or on the tracts of lava that form oases in the desert. This barren Nyika offers few attractions for man or beast, and both native traders and European explorers have hastened over it by the easiest routes to the richer countries of the Central Basin. Hence although the region of the Victoria Nyanza has been fairly well explored since first visited by Speke, the country to the north of the available routes to it has been largely left unvisited. Teleki in 1888-89 followed the great rift valley northward to Lake Rudolf; while Piggott, Peters, Hobley, and others made known the main points in the topography of the Tana Valley. But to the north of the Tana, and to the east of the Rift Valley, was a vast region of which nothing was known, except what could be gathered from the rough records of various Arab and Suahili traders, whose itineraries had been published by New and Denhardt.

"Purely in the interest of science," Mr. Chanler organised an expedition to explore this unknown land. He was fortunate in securing Teleki's able assistant, Lieut. Ludwig von Höhnel, as his companion and cartographer, and also a servant who had previously accompanied the author in a journey to Kilima Njaro. The three Europeans landed at Lamu, and formed a camp on the mainland at Mkonumbi, where they devoted three months to the organisation of the expedition. Seldom did an expedition have fairer prospects of success. Time was apparently no object, and perhaps the fact that Mr. Chanler's second name is Astor, explains why he was in the same fortunate position in regard to money. The three Europeans were men of experience in African work; they had a magnificent equipment; they had enlisted a powerful force composed of seven Somali, twelve Soudanese, and 140 Zanzibari, while Pokomo canoemen and others were engaged as required. The trade goods and armament were as suitable as the best local authorities could suggest or money buy; and their train of baggage animals and flotilla of canoes were sufficient for taking to the head of the navigable part of the Tana stores enough to last for years. In September, 1892, the march began. After many troubles, owing to the unhealthiness of the country, quarrels between the Soudanese and Somali with the Zanzibari, leading to desertions, and the death of baggage animals, the whole expedition arrived at the British East Africa Company's deserted station at Hameye. The party followed up the Tana to the confluence with the Mackenzie River. They ascended its valley, expecting that it would be the Guaso Nyiro; they found, however, that its volume gradually lessened, and that the river rises from various sources in the Jombani Mountains. Some distance further north they reached the Guaso Nyiro, which flowed to the east. They followed it till it was lost in a vast swamp known as Lake Lorian, and thus it never reaches the Tana. This was the first of the two principal discoveries made by the expedition, and it is interesting to remark that it was reported by New, from native information, as early as 1874. Disappointed at finding Lake Lorian to be only a swamp, Chanler and von Höhnel returned to the reserve camp, which had been left under Galwin at Hameye, indulging in some fighting with the natives on the way. They had some clear views of Mount Kenya, the height of which Höhnel gives as 19,650 feet; my estimate having been 19,500 feet. They started north again and moved the reserve camp to the country of the Daitcho. Chanler and von Höhnel then set out in search of a tribe known as the Randile, in order to purchase camels with which to carry their goods across the deserts to the north. They found the Randile, but could not persuade the tribe to sell camels. The account of this tribe is the most important contribution made by the expedition to African geography. For years past there have been legends of a race of "White Galla," and the traditions have come from several quarters, all pointing to the country to the east of Lake Rudolf as their home. Chanler does not refer to these legends, though they are known to all readers of Rider Haggard's novel "Allan Quartermaine." His description of the people (pp. 311-322) is the most important thing in the book, and is especially valuable as it is a simple statement of facts, every line of which shows careful observation and accurate record. The author describes the people as having a "prevailing light colour straight hair, and blue eyes," while they practise a circumcision of the navel and other rites not known among either Somali or Galla. Unfortunately there are no portraits, and no skulls were collected. The language contained many Galla words and some Masai, while the Somali could make themselves understood to the Randile. The words common to these languages, however, may easily have been adopted, and the author gives no information as to the grammar or structure of the language. Hence it seems impossible to form any idea as to the relations of this tribe; they are neither Bantu nor Nilotic, and perhaps are not even Hamitic. It seems most probable that they are the reported "White Galla," and that they entered the country from Northern Africa. Mr. Chanler's account only serves to whet our appetite for more information about this remarkable tribe. It is greatly to be hoped that the next traveller who can possibly enter into communication with it, will bring back portraits, or preferably a skull, and also get some idea of the grammatical form of the language.

Having failed in the main purpose of the visit to this tribe, Mr. Chanler returned on his tracks to the reserve camp in Daitcho, and thence marched west to join von Höhnel

at the southern end of the Loroghi mountains. The intention was to go westward to search for another tribe from which to buy transport animals. Sayer was reached, and some guides belonging to a tribe designated by a name which is no name—Wanderobbo—were secured. The country was in famine, and the Wanderobbo were starving. They begged Chanler to kill them some food, and he and von Höhnel spent some days shooting elephant, during which the author had several extraordinary escapes. He was preparing to start westward, when von Höhnel was knocked over by a rhinoceros and seriously injured. He was carried back to Daitcho, and thence sent to the coast. From this time the story of the expedition is a catalogue of disasters. All the camels had long since been dead, and most of the repeated relays of donkeys had suffered the same fate. Galwin was sent back to Ukamba to buy more of the latter. The Tana rose in flood, and for months the two halves of the expedition were separated; meanwhile the remaining donkeys were dying, and the rainy season, during which alone it was possible to cross the northern deserts, was being spent in enforced idleness. Then the Zanzibari suddenly mutinied and marched in a body to the coast. Soon after this the Soudanese, frightened by some preparations for the arrest of any Zanzibari who might be found, also bolted. The author had to destroy his stores, worth 9000 dollars, and return to the coast, which he reached at Mombasa after an absence of sixteen months.

The last pages of the volume contain the story of quarrels with the authorities at Zanzibar in regard to the treatment to be given to Chanler's deserters, who had been detained in Zanzibar. The author is very severe in his condemnations of the Zanzibar and British authorities. He declares that they suggested and instigated the mutiny, or at least gave the leader "something stronger than a hint" (p. 466); and on Mr. Chanler's return to Zanzibar, he was unable to obtain any assistance from them in securing the punishment of his men. The Prime Minister of Zanzibar, Sir Lloyd Matthews, held that the porters were justified in their desertion, and instead of punishing them, demanded from Mr. Chanler the full amount of pay due to them—a demand with which the author refused to comply. The question is an important one, but it is unnecessary to discuss it here. Mr. Chanler is naturally angry with the men whose desertion ruined his plans, and with the authorities who subsequently believed their story and took their part. Mr. Chanler admits that he has no very satisfactory theory of his men's desertion, which took him quite by surprise; or why the Zanzibar authorities should have urged his headman, Hamidi, to organise the revolt. But no one who knows General Matthews, and his readiness to help the traveller of any nationality who applies to him, will credit the charges made against him.

It is a pleasure to turn from the sad story of foiled plans, wasted chances, and angry accusations, to consider the value of Mr. Chanler's work, which represents a substantial addition to our knowledge of British East African geography. The author's text and Lieut. von Höhnel's magnificent map (which unfortunately often differ greatly in the spelling of the place-names) are contributions to the knowledge of British territories for which English naturalists and administrators must be grateful. Mr. Chanler has given us a map of an unknown region, discovered a most remarkable and interesting tribe, solved an important geographical problem, and made valuable scientific collections. He achieved these results by a generous expenditure of time and money, and at the cost of great personal hazard and hardship; and if he did not carry out the whole of the ambitious scheme at which he aimed, he displayed magnificent perseverance and courage in trying time after time, by route after route, to traverse the barren desert before him.

We cannot, however, but regret that Mr. Chanler's journey involved considerable bloodshed, and that the spirit with which he regarded this, may be gauged by his remark (p. 329), "I could not permit myself to indulge in the pleasure of an attack," although "the temptation to yield [to the entreaties of his men to seize the rich herds of a tribe with whom he had contracted the rite of blood-brotherhood] was, I must admit, next to impossible." J. W. Gregory.

APOLLONIUS OF PERGA.

Apollonius of Perga: Treatise on Conic Sections. Edited in Modern Notation, with Introductions, including an Essay on the Earlier History of the Subject, by T. L. Heath, M.A. Pp. clxx + 254. (Cambridge: at the University Press, 1896).

The assertion made in the opening lines of the preface to the book now before us, that "to the great majority of mathematicians at the present time, Apollonius is nothing more than a name and his "Conics," for all practical purposes, a book unknown," is probably well within the truth. That this should be so is a pity, because the work of the great geometer is not only valuable and interesting in itself, but affords an excellent example of the methods of Greek geometry at its best period.

Nevertheless it must be admitted that this state of things is not altogether surprising. To read through the "Conics," say in Halley's folio edition, requires not a little courage and perseverance. A modern geometrician, approaching the text for the first time, cannot fail to be struck, and is in most cases repelled, by the curious combination of crabbedness and diffuseness which it appears to present. On the one hand the nomenclature is really very concise, almost as much so, in fact, as the quasi-algebraical notation at present in vogue; on the other, there is an elaborate array of general enunciation, particular enunciation, distinction of cases, construction analysis, synthesis, and conclusion—all in strict accordance with the logical scheme which had become orthodox long before Apollonius's time. Formal demonstrations are given of propositions which we should be apt to dismiss as intuitively evident, and a preference is shown for indirect methods of proof which, in some cases, almost amounts to perversity.

Besides this, the reader who wishes to appreciate the "Conics" has to overcome a real and serious difficulty arising from the peculiar form in which the argument is presented. The Greeks elaborated the methods of geometrical proportion and the application of areas until they possessed an engine which, in capable hands, is, up to a certain point, as effective as the methods of modern

analytical geometry. In fact, a considerable part of Apollonius's treatise is coordinate geometry pure and simple; but it is expressed throughout in a strictly geometrical form. This is not without its advantages, both theoretical and practical: it avoids the thorny question of the continuity of numerical quantity, and it compels the reader to realise the meaning of every step that is taken. It is not unlikely that a well-trained Greek mathematician could follow the geometrical demonstrations as easily as the modern analyst can assimilate the corresponding algebraical proofs; it is anything but easy for one who has been brought up on the system now current to familiarise himself with the methods and points of view which prevailed in the age of the Ptolemies.

Still the labour is well worth undertaking, and Mr. Heath's edition will do much to lighten it. It may be well to state at once that the book will not relieve the serious student of the duty of consulting the original text. The editor, after performing the laborious task of literally translating the whole treatise, decided, very wisely, we think, not to publish it in that form. Instead of this, he has recast it into a form similar to that employed in most text-books on geometrical conics; he has occasionally condensed several propositions into one, made some slight rearrangements of order, and omitted, or merely given an abstract of, a certain number of propositions which are either of slight importance, or indirect proofs of converses by the usual *reductio ad absurdum*.

The result is that the English reader has before him the substance of Apollonius's great work, in a notation with which he is himself familiar, while at the same time he may, with a slight effort, read it back into the geometrical form of the original. In this sense it deserves to be called an edition, and is not a mere caricature tricked out with modern "improvements." Apart from the notation, the book really gives a trustworthy presentation of the contents and method of the original; the amount of alteration which the actual text has undergone may be estimated by the literal transcripts of Book III. Prop. 54, and Book II. Prop. 50 (one case), which will be found on pp. lxxxix–xciv of the Introduction. Some may object that the condensation is excessive; but we are inclined to think that this is not the case, when we consider the object which the editor had in view, namely to provide an edition "so entirely remodelled by the aid of accepted modern notation as to be thoroughly readable by any competent mathematician."

In this praiseworthy aim Mr. Heath has certainly succeeded, and it may be hoped that the "Conics" will now attract the attention which it undoubtedly deserves. The more the treatise is examined, the more evident become its power and comprehensiveness. Apollonius begins by considering any plane section of a circular cone, not necessarily right, and at once obtains a result equivalent to the equations of the parabola, ellipse and hyperbola in the forms

$$y^2 = px, \quad y^2 = px \pm \frac{p}{d}x^2$$

referred to a diameter and the tangent at one end of it; p being the parameter, and d the corresponding diameter. It is to be observed that, in the first instance, Apollonius speaks of *the* diameter, namely the particular one associated with the axial triangle of the cone. He then goes on to prove the existence of a conjugate diameter, and shows that any chord through the centre is bisected there: then, after a discussion of tangents, comes a very remarkable section, in which the transition is made from the original diameter and the tangent at one end of it to any other diameter and corresponding tangent. Every one is more or less aware of the fact that Apollonius practically solved the problem of drawing normals to a conic from any point in its plane; it is perhaps hardly so well known that he was acquainted with many of the focal properties of central conics, with the auxiliary circle, and with the harmonic properties of poles and polars. Oddly enough, the focus-directrix property of a conic does not appear, and was apparently unknown to Apollonius; the directrix is never used or mentioned, and the foci of a central conic are obtained by a construction equivalent to $AS.SA^1 = CB^2$. For this reason, no doubt, the focus of a parabola is not used or mentioned. But, with this one exception, almost all the principal theorems of ordinary geometrical conics are to be found in this treatise, composed more than twenty-one centuries ago.

The text of Mr. Heath's edition is preceded by a very valuable introduction, in which will be found an excellent account of the earlier history of conic sections among the Greeks, followed by an instructive essay on the characteristics and methods of Apollonius. This, with the appendix on the terminology of Greek geometry, will be of great service to those who may feel attracted towards research in the history of mathematics; a subject not interesting to many, but fascinating to the few who combine the instinct of an antiquarian with the necessary linguistic knowledge and mathematical ability.

One or two suggestions may perhaps be made in anticipation of another edition. A glossary of Greek technical terms, or at any rate an index of them, with references to the pages of the introduction where they are explained, would be a useful addition. The figures, on the whole, are clear, but some of them might be more accurately drawn; and in some of the longer and more difficult propositions it is very inconvenient to have to turn back to look at a figure on a previous page.

G. B. M.

THE HARE, FROM THE FIELD TO THE TABLE.

Fur and Feather Series.—The Hare. Edited by A. E. T. Watson. 12mo. Pp. 263. Illustrated. (London: Longmans, Green, and Co., 1896.)

FROM the first it was evident that the beautifully illustrated volumes of the "Fur and Feather Series" would appeal more to the sportsman and the *bon-vivant* than to the naturalist. That this is the case with the present issue may be inferred from the fact that out of a total of 263 pages, only a paltry sixty-two are devoted to what the author calls the natural history of the hare. As a matter of fact, it is impossible to apply the term "natural history" to the subject of more than the first forty-eight pages; the third chapter in Mr. Macpherson's

section of the work being devoted to the legislation concerning the animal in question, while the fourth bears the mysterious title of "The Hare and her Trod." From reading the text, we infer that "trod" has something to do with poaching, although of its precise signification we are still in ignorance.

In the preface to the series the editor makes it to be understood that the natural history of the animals forming the subjects of the different volumes will be treated somewhat fully. We are, however, very doubtful whether the more or less discursive gossip communicated by Mr. Macpherson is entitled to be regarded as natural history at all. There exist, it may be remembered, as models for popular monographs of any particular animal, the little volume on "The Horse," by Sir W. H. Flower, and the more pretentious work of Prof. Mivart on "The Cat"; and the author would, we think, have done well to have followed somewhat on those lines. Instead of having done this, we are not even told that the hare is a rodent, much less do we learn anything about its relatives of the same genus, and the points in which these latter differ. Beyond a few observations as to its occurrence in the different counties of Britain, and certain variations in colour and size assumed by the animal in some European countries, we are left absolutely in the dark as to the geographical range of the common hare—a subject which well merits full consideration in a work of this nature. Throughout the first chapter we find no mention of either the generic or specific names of the hare; a matter which might be passed without comment, were it not that on page 12 both scientific names of an unimportant parasite are introduced without any possible advantage. When, however, we reach page 30, we find mention for the first time of the genus *Lepus* in connection with two American species; the reader—if not a naturalist—being left to find out for himself whether the common hare is or is not a member of the same genus. What might be the aforesaid uninstructed reader's view as to the zoological position of the rabbit, we dare not hazard a guess!

Such observations as are given on the natural history of the hare, appear to relate chiefly to its breeding habits, its marvellous speed, and the depredations it commits on farm and garden crops. Although doubtless accurate enough in this way, they are very far from forming anything like a complete history of the animal, and are too discursive for our own taste, even in a popular book. Nothing in the way of new facts appears to be given, although this may well be excused.

As may be inferred from what we have written, the whole of the natural history portion of the work is from the pen of Mr. Macpherson. Several authors—among whom may be named the Hon. G. Lascelles and Mr. C. Richardson—are, however, responsible for the sporting sections; whi e the chapter on cookery has been written by Colonel K. Herbert. Whatever may be its shortcomings from a zoological point of view, the work, so far as we can judge, from the sporting aspect is in every way admirable, and it ought specially to become an invaluable companion to the country gentleman. The numerous fine illustrations make the volume excellent from an artistic point of view.

R. L.

OUR BOOK SHELF.

Grundriss einer Geschichte der Naturwissenschaften. Von Dr. Friedrich Dannemann. I. Band. Erläuterte Abschnitte aus der Werken hervorragender Naturforscher. Pp. xii + 375. (Leipzig: Wilhelm Engelmann, 1896.)

The idea upon which this book is constructed is an admirable one. By means of extracts and translations from the writings of great philosophers and investigators, a panorama of scientific history is presented in a most attractive form. Beginning with Aristotle and his Natural History, the author passes before the reader in historical succession the works and thoughts of Archimedes, Copernicus, Galileo, Gilbert, Kepler, Newton, Huyghens, Laplace, Lavoisier, Blumenbach, Cuvier, Darwin, and the host of other great thinkers and workers, who have helped to build up the edifice of scientific knowledge. To do this, Ostwald's excellent series of "Klassiker der exakten Wissenschaften" have been largely utilised. But we hasten to remark that the present volume does not merely consist of extracts and illustrations from series of reprints. A biographical note precedes the story in which each investigator tells of his work, and helpful editorialnotes are distributed throughout the book.

The work will be completed in two volumes, and we look forward with pleasure to the publication of the second one. The best text-book is the one which brings the student into close contact with the investigator, and thus creates in him a spirit of emulation. Dr. Dannemann's volume shows how this kindred feeling can be developed; therefore we welcome it as a valuable addition to scientific literature.

The Biological Problem of To-day. Preformation or Epigenesis? The Basis of a Theory of Organic Development. By Prof. Dr. Oscar Hertwig. Authorised translation by P. Chalmers Mitchell, M.A. Pp. xix + 148. (London: William Heinemann, 1896.)

The German edition of Dr. Hertwig's discursive treatise —"Präformation oder Epigenese?"—was so fully reviewed in these columns shortly after it appeared (vol. li. p. 265, 1895), that it is unnecessary to state again the criticism contained in it of Weismann's theory of the germ-plasm and doctrine of determinants, or to go over Dr. Hertwig's own theory of the development of organisms. The fact that this translation is an authorised one, and that it bears the name of Mr. Chalmers Mitchell, is a sufficient guarantee for biologists that the arguments set forth in the original edition are faithfully reproduced. In a lucid introduction, Mr. Chalmers Mitchell states the positions taken by Weismann and Hertwig, and points to the issue involved. This statement, and the glossary of technical terms, will be very helpful to readers who have but a general idea of the matters on which the argument turns. The German words "Erbgleich" and "Erbungleich," which Mr. Bourne proposed to translate isocleronomic and anisocleronomic, have been rendered by the words "doubling" and "differentiating." The word "rudiment" has been used as the equivalent of "Anlage," and most biologists will agree that it well covers the meaning of the German word.

Every one interested in the problems of heredity will be grateful for this translation of a very important treatise.

The X-Rays. By Arthur Thornton, M.A. Pp. 63. 25 illustrations. (Bradford: Percy Lund and Co., Ltd. 1896.)

This slender brochure contains a general statement of the nature of sound, light, electrical vibrations, and electrical discharges through gases, together with brief instructions for observing and photographing Röntgen phenomena, and an explanation of the theories concerning the nature of Röntgen rays. For readers desirous of obtaining an idea of the prominent features of Röntgen's discovery, the book may be recommended.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Sun-spots and Faculæ.

THE following account of the nature of sun-spots and of the faculæ commonly found associated with them, explains these phenomena by refraction through the sun's atmosphere on the supposition that the centre of a spot is the centre of a high-pressure area or anticyclone.

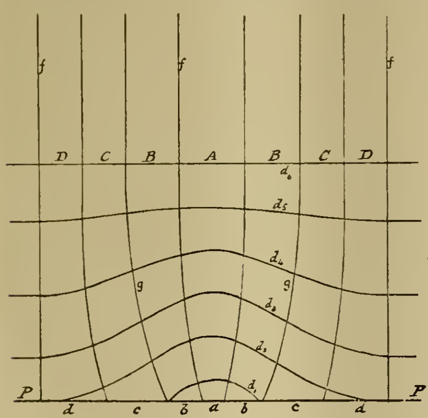
The descending central current in a solar anticyclone is caused by the exterior portion of the sun's atmosphere being at a temperature less than is consistent with convective equilibrium; consequently the whole of the descending column is colder and heavier than the atmosphere at the same level outside the area affected. The result is that the density of the atmosphere near the *base* of the column is increased, as compared with the normal density at the same level, by three different causes, viz.:—

(1) By lower temperature.

(2) By greater pressure, resulting from the upper portion of the column being colder and heavier than the normal at the same level.

(3) By additional pressure, resulting from the downward motion of the column being arrested near the photosphere; hence the pressure at the base is increased by inertia.

In the diagram annexed (a supposed section through the sun's atmosphere at a high-pressure area), the surface of the photosphere is represented by the line P P, and the successive surfaces



of equal density in the atmosphere are represented by the lines d_1, d_2, &c. These surfaces, indicating greater density in the centre of the area affected, must be convex-outwards in the centre, and concave-outwards near the margin, where they join with horizontal equal-density surfaces in the undisturbed atmosphere outside the anticyclonic action.

The area in question is seen from a distant point in the direction of E by the rays of light which emerge from the atmosphere in approximately parallel lines, represented in the diagram by the lines *f f f*. These rays before emerging must pass through the atmosphere by such courses as those represented in the diagram; that is to say, as they cross successive equal-density surfaces, moving as they do from a greater density to a less, they are refracted in a direction *less* perpendicular to these surfaces. The greatest deflection will occur about the positions of the lines *g g*, which cross the surfaces where these are most inclined to the photosphere. The areas A and B B will thus appear dark because they are seen by the light from smaller areas of photosphere, *a* and *b b*. As drawn in the figure the circular area, A, is nine times the area *a*, and consequently its mean brightness would be only one-ninth normal brightness; and the annular area, B B, being three times the area *b b*, would appear one-third normal brightness.

Beyond the greatest deflection lines, *g g*, the annular area on the photosphere is of greater width and less diameter than the corresponding annular area at the surface of the atmosphere. As drawn in the figure, the annular area, C C, is equal to *c c*, and would appear of normal brightness; while the area, D D, is about two-thirds of *d d*, and would appear of one and a half times normal brightness. In this region one or more faculæ would be seen surrounding the spot; one only if the concave-outwards curves of the equal-density surfaces were superposed one on another, as in the diagram; while if some series of such curves extended beyond others, more faculæ would be seen.

The occurrence of "eruptive prominences" near (but not at) the position where a spot has disappeared on the margin of the sun, is accordant with an anticyclonic motion round the spot; for this motion premises a rising-up of the lower atmosphere in the outer portion of the area affected. So also the greater width of the absorption-lines of the solar spectrum over a sun-spot, indicating that the absorbing atmosphere is there of greater pressure, is accordant with the theory here advanced.

It should be noticed that the brightness of the surrounding faculæ according to this theory arises simply from the light in which the spot is deficient.

JAMES RENTON.

Observatorio Nacional, Cordoba, Argentine Republic.

Sailing Flight.

IN NATURE, May 14, p. 25, you have a notice of two works on flight of birds, and I am rather surprised to see that the theory of upward currents in the air is still adhered to.

In NATURE, November 4, 1880, I laid a few remarks before you on this subject, aided by a little diagram, and on re-perusing this can see little to add to them, and nothing to alter.

It seems to me that upward currents of air, to account for sailing flight of birds, is, firstly, quite needless; secondly, they cannot be seen or proved to exist; and thirdly, the entire absence of such currents can be (at least out here) optically demonstrated.

As stated in my note (November 4, 1880), above referred to, we have two steady winds out here, from N.E. and S.W.; they are not at all violent or gusty—indeed, if directed vertically they could not possibly lift and sustain a 20 lb. cyrus or pelican.

But the utter absence of vertical air currents in our N.W. wind, at the very time the large birds are soaring in it, is beautifully demonstrated by the tufts of cotton, blown from the burst pods of the tall cotton trees, *Bombax malabaricum*.

For many years I have had a rather large telescope, through which to study the Noga Hill villages and cultivation, at six to thirty miles south, and for long was puzzled by the frequent appearance of small white objects, which slowly crossed the field, horizontally, at all distances and elevations, and at a speed of about ten or fifteen miles per hour. At last I found they were cotton tufts, out of which the little seed had dropped, and the beautifully steady and horizontal paths of thousands, at all distances, was often remarkable, at the time the birds were soaring. Anything approaching vertical air currents must have been at once detected, and easily visible. I have for hours watched the sailing, at 1000 and 2000 feet, of Cyrus, called here Korson (*Grus Antigoni*); Pelican, called here Dherra (*Pelicanus*); three Vultures, called here Hogren (*Gyps Inds.*), and two larger kinds; two adjutants, called here Bov Tokla (*Leptoptilus Argala* and *Nudifrons*); one jabiru, called here Telia Hareng.

Now, not one of these birds are ever seen sailing in a straight line, unless when descending. They cannot rise, or even sustain themselves, without flapping the wings, unless in a breeze, and when moving in a curve or spiral.

For the first 200 or 300 feet, in rising, they flap vigorously, and when well above the surface eddies, begin sailing in spirals, rising ten and twenty feet at each lap, wings held rigidly extended, and the tail alone seen to move now and then, and so on to 1000, 2000 and 3000 feet.

The primary feathers are each *widely* separated, thus giving a superposed aëroplane, at the wing extremities—

the body, say 20 lb., suspended between and below them. Each primary feather, which naturally is bent thus—

is strongly bent up, by a force equal to 8 oz., thus—

The sustaining is at the extremities, mainly. When going round *with* the breeze, the speed obviously increases, and the kite-like lift takes place when the bird turns and *meets* the same, the lift being visible, if near, and the speed also obviously slowed down.

But the drift of the rising spiral is to leeward. Varying *momentum* (of bird) in the resisting medium, must be noted; a stuffed albatross, or aëroplane, hung in a draught, will not solve the rising riddle.

The wing-plane for the moment is always part of a *cone*, outer wing highest.

When pelican travel for great distances in a straight line, their flight is at times peculiar, and they fly following each other, each bird alternating flaps or sails, thus—

the line of birds a series of waves. Our large hornbills, *Buceros bicornis*, behave in the same way.

I believe that when we look up and see a crowd of very minute specks some 5000 to 8000 feet above us (binoculars often needed), we see birds which have gone up there for coolness, and to go to *sleep*—to doze, at any rate. There is an entire absence of the mental and physical alertness and agility, which would be *constantly* needed if they depended on inequalities of wind pressure, and equally sudden, and invisible, *up gusts*, to save themselves from falling.

Herr Lilienthal is probably on the right trail. I see he desires to turn and meet the breeze; but in this movement, I fancy the upper central aëroplane—so high above the centre of gravity—will turn him over in a strong wind. In the bird's case (when turning) there is very obviously strong centripetal counter pressure, and great speed, quite sixty miles an hour I should suppose, at end of the leeward lap.

I notice that "W. J. S. L." (second paragraph, p. 301, January 30) assumes that the speed at times would be *slower* than the wind. This could only be when stopping. In the bird's case, the lifting is mainly done when it turns and meets the wind, and speed is slowed down, and the overturning is prevented, when the wings are thus, to the wind, by the great *lateral* expanse. There is none of this latter, in the centrally superposed plane machine; the bird's great lateral steadiness is structurally absent.

Soaring machines may be of two types: A, those *containing* their own power; and B, those deriving it from the surroundings only. There is no screw in the stern of the "Bov Tokla," as he wheels round and round close over me, as I sit hidden in a tuft of grass on the wide plain. Rising to windward, he circles over me at 200 feet or so, and with binoculars, or even without, I can see each feather, and hear the loud noise they make; there is never a move, except a little in the tail, yet lap by lap the bird steadily rises, and as steadily, if slowly, gets a drift to leeward.

I do not suppose the bird can soar without expenditure of energy; all I desire to point out is, that upward air currents do not lift and sustain it, also that the lifting is seen to be applied to the primary wing feathers almost entirely, and in a way which shows the lift is due to lateral translation. Tie a primary at the end of a long light stick, and on whirling it the effect is obvious.

S. E. PEAL.

Sibsagar, Asam, June 21.

The Position of Science at Oxford.

IT is notoriously difficult to express one's whole meaning in a condensed article. In so far as the article on the position of science at Oxford referred to the teaching of science at public schools, I see from Mr. C. I. Gardiner's letter that I have failed to express my meaning, and I must hasten to remove the impression that I intended to cast any reproach on the science masters of our public schools. I find it, indeed, difficult to understand how any one could have mistaken my meaning as much as Mr. Gardiner has done, seeing that I wrote that in every public school there are one or more science masters of tried capacity; a statement, I submit, which is entirely at variance with Mr. Gardiner's interpretation of my remarks. He makes me say that there is an absence of efficient teachers in scientific subjects; a statement which I never made, and could not make, for it would be manifestly untrue. I must admit, however, that a single sentence, "taken on the whole the science teaching at our public schools is bad," was unfortunate: I should have said that the value attached to science teaching at our public schools is altogether insufficient. Let me assure Mr. Gardiner that the last thing in the world that I should wish is that anything should be said or done to depreciate the attainments or the authority of science masters. Perhaps I may be allowed to explain. The efficiency of a machine depends firstly upon its excellence, secondly on the conditions under which it works. I do not dispute the excellence of science masters, but, speaking generally, I deplore the conditions under which they work in public schools. I stated that in public schools the inducements to learning science are very few (not nil, as Mr. Gardiner misquotes me); secondly, that it is openly discouraged; thirdly, that boys are apt to neglect studies which may safely be neglected. I adhere to each and all of these propositions. Boys, *pace* Mr. Gardiner, are as much impelled by emulation as by interest and fear (heaven forbid that fear of the cane should ever be associated with scientific teaching). Mr. Latter, in his valuable letter, throws the weight of his experience in favour of my statement: "A promising boy cannot make up by his science for deficiency in classics or mathematics . . . whereas the acute classic, however obtuse in science, is in no way hindered on his path to sixth form." No more need be said: the great inducement of emulation is wanting. If a boy neglects classics and mathematics he fails to rise in the school, is superannuated and sent away. If he neglects science, whilst working respectably at classics, he may incur formal reproof, he scarcely incurs reproach; at any rate he is in no danger of superannuation. Is it not safe, then, to neglect science? How Mr. Gardiner could have construed a harmless sentence into an attack on science teachers, I am at a loss to conceive. His conclusion is certainly not contained in the premisses, and I may be allowed to remind him that jumping to conclusions is hardly a scientific proceeding. As to the discouragement of science being no longer in existence, I can only say that Mr. Gardiner's experience is happier than mine. I trust his experience will soon become universal.

Boys do come to Oxford and to Cambridge destitute of scientific ideas. I have ample experience in Oxford, and my Cambridge friends make the same complaint. There are, of course, some few who have made science a speciality, and are well grounded, but the majority are absolutely ignorant of the alphabet of science. It is a well-known fact, and may be proved in the following way. Let it be proposed that a paper in rudimentary physics be compulsory in the "Little Go" at Cambridge, and in "Smalls" at Oxford. The proposal will be rejected by both Universities, because, it will be alleged, this minimal knowledge of science would be an insuperable barrier to the classical scholar. Moreover, it is the universal experience of those who are engaged in science teaching in the two Universities, that much of their energy is wasted in teaching the alphabet of science to those who propose to take honours in that subject. That alphabet might have been learned at school. I make no

reflection on the science masters. If the genius of the schools were something more than classical, if boys could get the same promotion for science that they do for classics, the opportunities of the science master would be increased a hundred-fold, and scientific knowledge would become the rule instead of the exception.

Throughout the article on the position of science at Oxford, I referred to public schools, only once to science masters, and that once in a complimentary sense. It should have been sufficiently clear, in spite of my unguarded sentence, that it was the spirit, the general scheme of education of our public schools, that I was attacking. Mr. Latter's letter justifies my attack. There are points in his letter which I would willingly discuss, but space forbids my entering into them now. As to the questions of Greek and the precedence of chemistry and physics over biology, there is much to be said on both sides. I will only say this: Mr. Latter is an accomplished zoologist, and his love of his subject perhaps leads him to under-estimate the intense interest which many young boys take in chemical and physical problems. After watching carefully a group of very small boys with whom I have familiar relations, I am convinced that they go after butterflies and fishes, not by preference, but because they have this opportunity of satisfying their thirst for natural knowledge, and have not the same opportunities for cultivating chemistry and physics. At any rate, if I offer to make hydrogen, or to exhibit an air-pump or an electric battery, the insects are deserted at once. Being a biologist myself, I write without prejudice in favour of the more exact sciences.

The Writer of the Article.

The Salaries of Science Demonstrators.

I fancy the incident referred to in the fable quoted by "O. J. L." (p. 271) must have happened some time ago, possibly when "O. J. L." was a tadpole himself. I am sure he would not think so lightly of our grievances if he fully realised the state of affairs in this pond of late years. At one time every tadpole who did good work had a reasonable prospect of developing into a frog on attaining a suitable age. Now there are scores of tadpoles, some of them grey-haired, who attend meetings, and croak to the best of their ability, and read papers bearing the name of some frog as joint author, but who seem fated to end their days in the tadpole stage because they cannot get sufficient food to enable them to develop into frogs.

This state of affairs is, I take it, largely attributable to the following cause. As all naturalists are aware, our ponds at certain seasons of the year are choked with frog-spawn. Under the old *régime* this spawn had to take its chance; some got dried up in the sun, and some got washed away by rain, so that only one occasional *ovum* here or there hatched. This process of survival of the fittest led to the production of a race of frogs eminently adapted to hold their own in the struggle for existence, and many of these have now acquired world-wide reputations. But Mother Carey, fearing lest any of the eggs that perished might contain the latent germs of some remarkable genius, has carefully tended this frog-spawn and hatched it in a laboratory fitted up with all the most modern incubators and other appliances, and has sometimes even nurtured it with County Council and other scholarships. So far so good. But as soon as the tadpoles are hatched, Mother Carey turns them adrift into our pond to fish for themselves, and takes no more notice of them. The result is that, where we had one tadpole formerly, there are now hundreds, struggling and starving each other out. Every morsel of food dropped into our pond (even if it be only a matter of £60 a year) leads to a terrible scramble, in which the best of us do not always come off first. I consider that we have a genuine grievance against Mother Carey on the ground that, after having devoted so much energy to hatching large numbers of tadpoles annually, she gives so little thought about finding us proper food at the time when we most need it. If we cannot all live on dry land, let us, at any rate, have a fair chance of developing our power of swimming like frogs in the water.

"An Aggrieved Tadpole."

The Date of the Glacial Period.

Mr. Davison has laid geologists under many obligations to him for his mathematical investigations of vexed or obscure questions. His suggestion in the *Geological Magazine*, that the glacial period would probably have left a long-enduring mark upon the iso-geotherms, seemed to me, as I dare say it did to other students of glacial geology, a promising one; and though a comparison, which I made of the gradients in thirty-seven cases within the glaciated area of Britain with sixteen in the unglaciated portion, failed to reveal any significant difference, still I have been disposed to ascribe the failure rather to the imperfection of the data than to any fault in the method. When, however, Mr. Davison (Nature, June 11, p. 137) extends the application of his formula to a comparison of two hemispheres, the insufficiency of the data is such as to entirely vitiate any results.

In the northern hemisphere there were available in 1885, when Prestwich wrote his memoir published by the Royal Society, 231 series of observations on the temperature of mines, tunnels and bore-holes, and it was only by what appeared to be the rather arbitrary elimination of an immense number of the records, that anything like an agreement could be obtained

What, however, is the body of evidence employed in the determination of the temperature-gradient in the southern hemisphere? One bore-hole in New South Wales! Whatever confidence we may feel in the care exercised by the observers, I cannot think that any general conclusions should be based upon this single series of observations.

There are several well-known bore-holes in the northern hemisphere in which the gradient is as far from the average given by Mr. Davison as is that of the Australian one, and, though various explanations were suggested, none was regarded as satisfactory. If Mr. Davison had referred to the Wheelton bore-hole in the 19th and 20th reports of the British Association Committee on underground temperatures, he would have found there a series of observations, made by a practised physicist, and repeated after an interval of a year under varied conditions, with practically identical results; yet here the increase of temperature was only *1° F. per 70 feet*. The St. Louis bore-hole, again, gave an average gradient of 88 feet; and though the result was regarded as erroneous, it was acknowledged that every care had been exercised, and no specific source of error could be suggested.

Taking all the circumstances into consideration, I think it will be generally conceded that, interesting as this Australian record may be, it throws no light whatever upon the vexed question of alternate glacial periods in the two hemispheres.

Percy F. Kendall.

Yorkshire College, Leeds, July 16.

TAXIDERMY AND MODELLING.[1]

That taxidermy has been almost an entirely neglected art is obvious to the least scientific visitor to even the best of our museums, when he regards the "deformed, distorted, and disproportioned" effigies that represent our commonest species. Every means, therefore, be it by example or precept, which will have the effect of impressing on the taxidermist the importance of his share in the exposition of natural history, and which will tend to raise what is at present little better than the knack of distending, more or less cleverly, the skins of animals with wool or shavings, to the science and art of where and why to "stuff" and reproduce, and how to pose, will be welcomed by all those who are responsible for instructing, by forms made up to simulate life, those desirous of becoming acquainted with the likeness and gait of animals which they have few or no opportunities of observing in a state of nature; and by those who turn aside to our museums to refresh their spirits with the sight of species which they have learned to love in the fields or in the sea.

The title of the work which heads this article is from the pen of Mr. Montagu Browne, the Curator of the Leicester Museum. That institution has obtained a considerable and deserved reputation for the excellence of many of its mounted groups, birds especially, as examples of the taxidermist's art, prepared by the skilled hands,

[1] "Artistic and Scientific Taxidermy and Modelling: a Manual of Instruction in the Methods of Preserving and Reproducing the Correct Form of all Natural Objects, including a chapter on the Modelling of Foliage." By Montagu Browne, F.G.S., F.Z.S., &c., Curator of the Leicester Corporation Museum and Art Gallery; author of "Practical Taxidermy," &c. With 22 full-page illustrations, and 11 in text. Pp. xii + 463. (London: Adam and Charles Black, 1896.)

we believe, of the curator himself. A work, therefore, on the subject in which he is an expert deserves attention. Taken as a whole we may at once say, that its careful perusal will well repay the practical taxidermist and modeller, for he will find the book to be a very detailed guide to the more important methods of reproducing animals and plants for exhibition purposes. Curators of museums, even though they are neither taxidermists nor modellers, will derive many excellent suggestions from its pages.

The object of the work, the author informs us, is to pave the way for the "happy combination" of qualities which he thinks the taxidermist should possess. "The future and hope of taxidermy will be," he says, "the welding of the educated artist, designer, modeller, sculptor, biologist and naturalist; and the two last are by no means synonymous terms, as some might suppose. When this happens—and there is no reason why all these attributes should not be combined in one individual—taxidermy will become an exact science relieved as painting is at present by poetic inspirations." In this opinion Mr. Browne but supports what Dr. Shufeldt, whom he quotes, has written on the subject of the taxidermist's training. Such a concatenation of qualities in one person will, we fear, remain a dream of the future. Life is not long enough for one individual to master a series of professions each arduous enough in itself for most men. Indeed, we hardly desire such a "professor" of many callings. Knowledge is never useless, but in our opinion it appears unnecessary to insist that the taxidermist of the future shall possess a scientific training in biology, or should know more anatomy and osteology than may be gained in his apprenticeship, and by very careful observation of the bodies of the animals he has to deal with; for he has to reproduce only the external surfaces as affected by various attitudes, and whichever of these he desires to reproduce he will have noted in his preliminary study of his subject. He has but to copy faithfully—neither to create, nor to use the painter's "poetic inspirations."

Following a short account of the origin and progress of taxidermy, the succeeding seven chapters (some 290 pages) deal with the skinning and setting up of vertebrates, and the preserving of invertebrates, by various methods; and also their reproduction by casting and modelling in paper, glue, &c. On these subjects Mr. Browne writes with undoubted authority and wide experience, and his instructions and descriptions are, therefore, of the greatest value. Besides the processes and methods long known and widely practised, the author claims to describe "methods of taxidermy and modelling not yet published, most of which are indeed absolutely novel, and at present confined to the Leicester Museum"; specially noteworthy among them is the mounting of the skin, which is fully described, upon a model of the body in paper, a process which, though tedious and demanding much labour and care, will probably prove to be a great improvement on that involving a "mannikin." An illustration of a model in paper of a headless tiger, on which the skin is to be fitted, is, through the courtesy of the publishers, reproduced here (Fig. 1).

FIG. 1.—Model in Paper of the Headless Body of a Tiger.

We are surprised to observe that Mr. Browne strongly decries the use of "arsenical and mercurial [corrosive sublimate] soap," as being very inefficient and too dangerous for use, and recommends in its place "a non-poisonous preservative soap" (of chalk, lime-chloride and musk) of his own devising. Notwithstanding this, we read on page 35, "the most perfect preservatives are probably those which contain [which the author's preservative does not] with alcohol a certain percentage of bichloride of mercury," and on other pages several formulæ so com-

pounded are recommended for use for skins infested with insects, for it prevents insect pests and mildew "ever appearing afterwards." Great care is always necessary in the use of poisons; but as there is no greater danger in using arsenical soap containing bichloride of mercury than an alcoholic solution of the salt, we are at loss to understand his strong denunciation of the evidently more efficient medium. The present writer has found no preservative equal to it, and has used it for thousands of skins, bird and mammal, in various regions of the globe, and cannot recollect to have lost one by moth, mite, or dermestes—except when the soap was insufficiently applied. Many of them also, after lying for years as dry skins, have been relaxed, and have proved all that could be desired. The alcoholic solution of corrosive sublimate applied to a tender skin renders it very brittle, a result entirely obviated when the salt is incorporated in the soap. Several formulæ, of which Mr. Browne claims the authorship, are given for the preservation of cartilage; but we miss any reference, either in the book itself or in the bibliography at the end, to Prof. Jeffery Parker's methods. He was one of the first, if not the first, to preserve cartilaginous fishes as "dry" specimens in museums, by very similar, if not essentially the same, processes as Mr. Browne.

Not the least valuable section of the book is the ninth chapter, describing "casting and modelling from natural foliage, flowers, fruits, algæ, fungi, &c., and their reproduction in practically indestructible materials,"—the Mintorn Art Fabric. This is quite a recent branch of the taxidermist's art—if it really belong to it—which is as important, and demands equal care an ability as the mounting of the specimen which it is to enhance. The reproduction in this material of the species of the British flora in our museums would prove a very great incentive to the study of botany, which even the best prepared herbarium can scarcely be said to do. How naturally such plants can be modelled may be seen from the second plate (Fig. 2), which we are kindly permitted to reproduce. The volume, which is dedicated to the *doyen* of museum reformers, Sir William Flower, is so beautifully printed, illustrated and bound, that we feel we cannot close our commendation of the author's part without a word of appreciation of the publishers' share in its production.

Fig. 2.—Models, in Fabric, of Sea-Aster and Flowering Rush.

PROGRESS IN STEREOCHEMISTRY.

To the stronger minds among men of science, exercised in abstract conception, and independent of such aids to the imagination as are embodied in drawings of atomic arrangements, models of molecules and even formulæ of atomic groupings, there is no doubt something almost repulsive in the representation of the molecule as a machine, a combination of mechanical powers. It is nearly forty years since the screw was suggested (by Pasteur) as a symbol of the atomic arrangement in tartaric acid, and now we find the lever introduced in such phrases as "the moment of a chain of atoms varying with its length." The wheel-and-axle has not yet been pressed into the service to explain atomic vagaries; and of the philosopher who shall venture to take this further step, the abstract thinkers of to-day will surely say, as Kolbe said of the chemist who was destined to succeed him in his professorial chair at Leipzig: "Hereby he declares that he has left the ranks of men of science, and has gone over to the camp of those philosophers of ill-omen, who are separated from the spiritualists by only a very thin *medium!*"

Yet as surely as Kolbe was succeeded by the stereochemist whose doctrines he denounced, so surely will the

vague atomic groupings of to-day be succeeded by definite systems, in which each atom will have its orbit mapped out with ever-increasing minuteness; for as long as the atomic theory endures, so long will it become more and more of a mechanical theory; and indeed it would be absolutely inconsistent, when we are perpetually striving to arrange the atoms of a molecule into groups, to give up all attempt to determine the relative positions and motions of the groups and of the atoms within them. It is as true to-day as it was when Kekulé published the statement in his "Aims and Achievements of Scientific Chemistry," that as the great present aim of physics is the elaboration of a system of molecular mechanics, so the great present aim of chemistry is the elaboration of a system of atomic mechanics, in which every reaction will be accounted for by the mass and motion of the reacting atoms. This may be deplorable; but those who think it most so, most keenly realise that it is true.

For instance, quite recently, in his plea for "Emancipation from Scientific Materialism,"[1] Prof. Ostwald wrote:—

"We read and hear with countless repetition the statement that the only intelligent explanation of the physical world is to be found in a 'Mechanics of the Atoms'; matter and motion appear as the final principles to which natural phenomena in all their variety must be referred."

With regard to physics, a similar acknowledgment is contained in the words of Duhem, uttered in 1894:—

"When the science of motion ceases to be the first in logical order of the physical sciences, and becomes only a special case of a much more general science, which embraces in its formulæ all the changes of bodies, the temptation will be less to try to reduce to the study of motion the study of all physical phenomena; it will be better understood that change of position in space is a problem no simpler than change of temperature or of any other physical property. Then we shall more easily avoid the most dangerous reef of theoretical physics—a mechanical explanation of the universe." (*Jour. de Mathématiques*, x. 207.)

Such statements as these are valuable, in that they remind us that even the most necessary of our present theories is a temporary makeshift—a crutch which indicates the weakness that it helps, and which we may hope to be able to discard.

This might be said, however, of most things that are useful; and it must be remembered that the same theory is not the best for every one. For each man that theory is the best which is the most stimulating, which best spurs him on to useful work, which urges and guides him forward into the unknown. Another theory may have more facts in its favour, but if these facts do not specially interest the worker in question, it will be of less value to him than a theory, otherwise inferior, which enables him vividly to realise, and aptly to utilise, those facts which do interest him.

Moreover, even if we admit that the atomic theory may be near the end of its existence, and that it may, and should, shortly be superseded by a more widely useful theory, it must yet be maintained that the way to hasten this consummation is to push the theory with all rapidity, and in every direction, to its extreme consequences, in the full assurance that, so far as it is incomplete, this will be the quickest way to demonstrate its deficiencies.

Now, among the consequences of the atomic theory, the consideration of the space relations of the atoms occupies the first place; it is not an extreme, but an immediate and a necessary consequence. For this reason alone, if stereochemistry did not exist, it would be necessary to invent it. But to find a *raison d'être*, stereochemistry needs no such arguments. It has justified its existence by its achievements.

The stereochemical explanation of the existence and properties of the two different substances formed when a carbon atom unites with four dissimilar groups of atoms, has long been generally admitted. As to the exact three-dimensional formulæ by which we should represent these two substances, both of which correspond to the ordinary formula $CR^1R^2R^3R^4$, differences of opinion exist; but it is certain that the formulæ must resemble those given in the figures (1 and 2), in so far as these represent three-dimensional arrangements, each unsymmetrical, but such that the two together form a symmetrical whole; in other words, each being the mirrored image of the other. And space-formulæ, in these respects similar, must be admitted for the two compounds formed by the union of a nitrogen atom with five different groups.

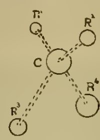


Fig. 1.

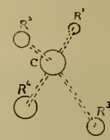


Fig. 2.

Fig. 3.

Fig. 4.

It is true that, beyond this, the services of stereochemistry are questioned by some chemists. Yet it cannot be denied that the tetrahedral grouping of the atoms combined with carbon forms a connecting link between whole groups of facts, in the most varied branches of organic chemistry, which, without it, would have been left in comparative isolation. But without entering into the necessarily complicated discussion of these developments, it may be shown, by the consideration of a single instance, that the simple original conception of the three-dimensional asymmetric grouping of dissimilar atoms about the carbon-atom to which they are attached, enables stereochemistry not merely to follow in the steps of structural chemistry, and to explain many anomalies which the latter leaves unaccounted for, but to push its investigations in advance, and to declare the space-relations prevailing in the molecules of substances as yet never analysed, and even never isolated.

The action on polarised light of a substance in solution is a test for the asymmetric grouping of the atoms in its molecules. Just as when we find a substance crystallising in two forms, such as Figs. 3 and 4, having the relation of the right and left hands, we know that these crystals will have the power of rotating the plane of polarised light to the right and to the left respectively; so when we find that a dissolved substance exerts a one-sided action on the light, we know that it possesses a one-sided molecule capable of existing in the right- and left-handed forms (Figs. 1 and 2); which, it will be observed, bear the same relation to each other as the crystal forms 3 and 4.

Further, it is known that although the two members of a pair of substances like those shown in Fig. 1 and Fig. 2, through the identity of their atoms and the equality of the distances dividing them, show no difference in their behaviour towards any ordinary substance, yet they differ entirely in their behaviour towards molecules which are themselves asymmetric. To go back to Pasteur's simile, they resemble equal screws with their threads turned in opposite directions. Both will fit the same hole equally well if it is an ordinary hole; but if it is a hollow screw, then everything will depend upon whether the thread of the hollow screw is right- or left-handed.

Conversely, if towards any substance the right- and

[1] *Science Progress*, February 1896.

left-handed molecules, $CR^1R^2R^3R^4$, act differently, we may conclude that this substance contains molecules which are themselves asymmetric. So that when we find, for example, a certain species of microscopic organism fermenting and destroying a "right-handed" sugar, but not attacking a "left-handed" sugar otherwise identical with the first, we may conclude that those molecules of the ferment which are concerned in the attack are themselves, all or some of them, of a decidedly right- or left-handed character. The line joining their atoms would itself be a spiral, the thread of a screw. And in fact we find living organisms to be largely composed of asymmetric molecules, albuminoids, which themselves exert a one-sided action on light.

It is evident, then, that there is a relation between a ferment and the substance it ferments, as between a solid screw and a hollow screw with threads which enable one to turn in the other.

And the recent researches of Fischer and Thierfelder show the relation between every turn of the two threads to be most intimate. In these experiments, twelve different species of yeast were obtained pure and free from other organisms, and fourteen different sugars were tested with each species of yeast. After eight days it was found that some of the sugars were completely fermented, some only partially, some not at all. And it was observed that the same ferment would attack sugars of widely varying composition, a sugar containing only three carbon atoms, *e.g.*, as readily as one with nine carbon atoms in its molecule. But directly it became a question of the geometrical structure of the sugar molecule the ferments showed the nicest particularity. In the case of sugars containing six carbon atoms and of exactly the same chemical composition, some would ferment readily, and others not at all.

For example, there were tested :

Dextro-glucose.	-mannose.	-galactose.	-talose.
O H C	O H C	O H C	O H C
HCOH	HOCH	HCOH	HOCH
HOCH	HOCH	HOCH	HOCH
HCOH	HCOH	HOCH	HOCH
HCOH	HCOH	HCOH	HCOH
HCOH	HCOH	HCOH	HCOH
H	H	H	H
I.	II.	III.	IV.

In each of these four molecules the atoms are the same in kind and in number. The only difference is that whereas in I. there is on one side of the molecule—say on the left, as in the formula given—only one OH group, in II. there are two OH groups on the left, in III. also two, but not the same two, and in IV. there are three. Now it is found that, with the same yeast-species, III. ferments with more difficulty than either I. or II., and the slight further change in the space-relations suffices to deprive IV. altogether of the power of fermenting. This is but one example of the way in which the yeast-cells pick and choose their food. Here, as Fischer observes, we have not simply to do with two similar substances of opposite activity—represented by screws having threads opposed throughout—but we find that of a great number of geometrical forms only a few satisfy the requirements of the yeast-cells; and these few forms are represented by screws in which the threads differ only as regards the direction of one or two of their turns. This may be illustrated by the figures below; for although it is impossible to give an exact representation of the geometrical forms of the molecules of the sugars in question, it is certain that the relations between their forms must correspond to the relations between the figures given, which are formed by a line starting from the COH group (a), joining C, OH, and H, always in the order named, and ending at the group CH_2OH (B). If the zigzag thus obtained be considered as the thread of a screw, it will be seen that in I. (Fig. 5) the thread is reversed at C^2 and again at C^3. In II. (Fig. 6), which also ferments readily, there is reversal at C^3 only, in

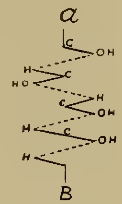


Fig. 5.

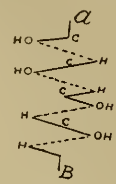


Fig. 6.

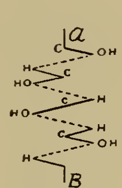


Fig. 7.

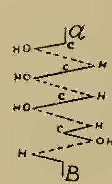


Fig. 8.

III. (Fig. 7), which ferments with difficulty, at C^2 and C^4, and in IV. (Fig. 8), which ferments not at all, at C^4 only.

These relations are shown yet more clearly in the following figures, in which the side of the OH group is represented by a broad curve, while the sharp angle is retained for the H side.

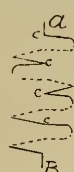


Fig. 9

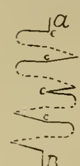


Fig. 10.

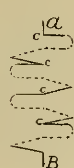


Fig. 11.

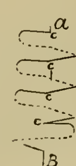


Fig. 12.

In the fermentation of all the sugars, the chief agent is, according to Fischer, proteid matter, a substance which is itself asymmetric, and which, being formed from the carbohydrates of plants, probably possesses a geometrical structure similar to that of the natural six-carbon sugars. Hence it can attack and ferment substances geometrically not far removed from these, *i.e.* from grape

sugar. The question arises, Why do not all yeasts ferment the same sugars? If the origin of the fermenting molecules is in all cases the same, has a change of environment power to alter them, provided many generations of yeast-cells are exposed to the same conditions? In order to answer this question, Fischer and Thierfelder attempted to breed a yeast which should ferment a sugar its ancestors were incapable of attacking. Starting with a yeast which could attack only dextro-glucose, they mixed this sugar with its own weight of a left-handed sugar (l-mannose), and gradually increased the proportion of the latter during three months—a time sufficient for many generations of yeast-cells to succeed one another. When the proportion of glucose was reduced to one-half per cent. the fermentation still went on, but, on reducing it to nothing, fermentation ceased altogether.

So far, then, this attempt has been a failure. In another direction, however, the research was developed with more success. The experiments described had been complicated by the presence of an unknown factor—the life of the fermenting organisms. Analogous experiments were therefore made with lifeless ferments, or enzymes, such as invertin, and emulsion, by allowing them to attack molecules differing only in the space-relations of their atoms. It was found that their power of discrimination was no less exact than that of the living cell. The difference between a glucose- and a galactose-grouping (I. and III. p. 323), which is merely a matter of H and OH changing places, is for them a difference absolutely vital. In the one case they attack the molecule, in the other they will have nothing to do with it. The explanation is similar to that given in the case of the sugars. Invertin and emulsin much resemble proteids, and no doubt possess asymmetric molecules. Their limited action on the glucosides is therefore to be accounted for by the supposition that the approximation of the molecules necessary for chemical action is possible only for molecules of similar geometrical build. To use Fischer's simile, ferment and fermented substance must fit like lock and key. For stereochemistry this image is the more valuable now that the observations have been removed from the biological to the purely chemical field of the lifeless ferments. And indeed for physiological chemistry, also, this last step is no less important, since very many of the processes which go on in the organism are effected by lifeless ferments, and must be largely influenced by the geometry of the molecule.

Nevertheless, those who already deplore the use of materialistic aids to the scientific imagination will find, in this image of the lock and key, but another count in their indictment of stereochemistry.

ARNOLD EILOART.

NOTES.

A REUTER telegram reports that the English tourist steamer *Garonne* arrived at Vadsö on August 2, and landed some of the members of the British expedition to observe the forthcoming eclipse of the sun. They proceeded at once to the south of the Varanger Fjord, where Her Majesty's cruiser *Volage* had already landed the astronomical instruments required for the observations. The steamship *Norse King* also arrived at Vadsö on Sunday with a large party of astronomers to observe the eclipse.

THE prospects of astronomers who have gone to Norway to observe the forthcoming total eclipse of the sun, are decidedly good. A telegram has just reached us stating that Mr. Norman Lockyer, assisted by officers and men of H.M.S. *Volage*, has established a camp on Kio Island, and completed the arrangements for observing the eclipse. As many as forty observers will be employed at this station in recording various characteristics of eclipse phenomena. There is every probability that fine weather will prevail on the day of the eclipse at the station selected.

CANADA is not only to be the meeting-ground of the British Association next year, but also of the British Medical Association. At the annual meeting of the latter Association, held in Carlisle last week, it was decided to accept the invitation to meet at Montreal next year, at the end of August or beginning of September. The British Association meets at Toronto on August 18, so that it will be possible for the medical members of it to attend both meetings if they wish to do so.

DR. A. BALDACCI has undertaken, during the present year, a botanical investigation of Northern Epirus, especially the district of Konitza.

THE annual meeting of the Italian Botanical Society will be held this year at Pisa, from September 10 to 17. The proceedings will commence with an evening reception, and several botanical excursions are arranged during the week.

WE regret to announce the death of Sir William Grove, at the age of eighty-five. His investigations in physical science, and especially the voltaic battery which bears his name, earned for him a wide reputation. He was elected a Fellow of the Royal Society so far back as 1840.

A METEOR of great size is reported to have fallen on July 24, at the mines of Santos Reyes in the State of Chihuahua, Mexico. A loud explosion was heard, and a mass of luminous matter was seen to fall, striking the side of a mountain, and bringing down with it in its course a large amount of rock. The meteor finally buried itself in the ground to a great depth.

AN important astronomical expedition left Chicago a few days ago for Flagstaff, Arizona, and ultimately for Mexico. Mr. Percival Lowell heads the expedition, and will make observations of Mars, assisted by Mr. A. E. Douglas. Dr. T. J. See, assisted by W. A. Coggeshall and D. A. Drew, will study double stars, and make a survey of the southern heavens. Mr. Alvan G. Clark accompanies the expedition, to put up the 24-inch telescope which has been taken.

REUTER'S correspondent at Tromsö reports that the Conway expedition has successfully accomplished the first crossing of Spitzbergen from west to east and back. Starting from their headquarters at Advent Bay, on the south side of Ice Fjord, the party ascended the Sassendal, at the head of Sassen Bay, and, branching off into a long lateral valley, climbed to the high land, which was found to be one vast glacier reaching nearly to Agardh Bay, on the Stor Fjord, or Wybe Jans Water, on the east side of the island.

THE retirement of Prof. Victor Horsley from the chair of Pathology in University College, London, has been made the occasion of presenting him with a testimonial in the form of a piece of plate and an album, as a mark of appreciation of the way in which he has advanced experimental pathology in this country. The album contains photographs of about fifty of the subscribers to the testimonial, together with a record of the work done by them, either in conjunction with Prof. Horsley or in the Brown Institution, and in the Pathological Department of University College, during the time he directed these laboratories.

AS already announced in these columns, the Committee organised by the Kazan Physico-Mathematical Society to obtain funds to found a memorial of the renowned Russian geometrician, N. J. Lobatchefsky, received the total sum of 9072 roubles (£1433) in support of that object. A circular received from Prof. Vassilief informs us that the fund has been utilised in the following manner. A capital sum of six thousand roubles has

been used to found a prize of 500 roubles to be awarded every three years for a geometrical work, and especially one on non-Euclidian geometry, printed in Russian, French, German, English, Italian, or Latin. The first prize will be awarded on November 3, 1897 (the centenary of Lobatchefsky's birth took place on November 3, 1893), and mathematicians competing for it must send in their works not later than November 3 (October 22). The sum remaining after the foundation of this prize has been devoted to the erection of a bust of Lobatchefsky, in front of Kazan University. The bust will be inaugurated on September 13 of this year, and it is hoped that as many foreign men of science as are able will be present to witness the ceremony.

A NOVEL anthropological discovery was made recently three miles from Waynesburg, in the south-western corner of Pennsylvania. A labourer, while ploughing, struck a number of stones, which proved to be graves of a character different from any heretofore discovered. Twenty vaults were found, each twenty-seven inches long, seventeen inches wide, and twelve inches deep, and each covered with a stone forty-two inches long, three inches thick, and twenty-eight inches wide at the head, thirty inches in the widest and twenty-four inches in the narrowest part. The stones were six inches below the surface of the ground. Each vault contained a skeleton of diminutive size, doubled up so as to occupy only eighteen inches of space, with the heads all in an unnatural position, and all facing the south. Under each skull was a turtle, placed as if for a pillow; and in many of the graves were skeletons of birds. The graves were arranged in the segment of a circle of almost four hundred feet in diameter. Many bone beads were found in the graves, but only one piece of metal, a small crescent-shaped copper ornament.

MR. R. H. SCOTT has sent us a copy of the report of Sir Walter Sendall, High Commissioner for Cyprus, on the succession of earthquake shocks, which we have already noted (p. 229) as occurring there at the end of June and the beginning of July. It appears that the first and most violent shock occurred about 11 p.m. on June 29, and up to the date of the report (July 4) the disturbances had continued without sign of abatement. Though most severe at Limasol, the shocks were felt from one end of the island to the other, and upwards from the sea-coast to the summit of Troodos. Mr. Mitchell, Commissioner at Limasol, reports that a shock of alarming intensity occurred at about 8.25 a.m. on July 3; the times of other movements of varying intensity felt on the same day are 12 (noon), 12.38 p.m., 2.52 p.m., 3.22 p.m. From the character of the individual shocks which, though at times very disquieting, did not produce the impression of intense and concentrated activity, it was concluded that the centre of the disturbance was at some distance from Cyprus.

THE last part (No. 12) of the first volume of the *Bollettino* of the Italian Seismological Society has reached us. The complete volume, of which we have from time to time noted the contents, includes twenty-seven papers, eight of these dealing with new instruments, four with studies of recent Italian earthquakes, and eight with the state of volcanic action in the south of the country. More than half the volume consists of notices of earthquakes registered in Italy in 1895. This section is communicated by the Central Meteorological and Geodynamic Office, and its value will be evident from the fact that it contains more than two thousand records of about 550 earthquakes. The majority of these are merely local shocks, perhaps too slight to be detected except with instrumental aid. In eighteen cases the epicentre lay outside Italy, and in three others the pulsations recorded were probably due to distant, but unknown, shocks.

THE Pigmy peoples are a source of perennial interest to anthropologists, as they undoubtedly represent a very ancient variety of the human race. The latest contribution to their osteology is a paper by Dr. R. Verneau, "On the Plurality of Ethnic Types among the Negrillos," in *L'Anthropologie* (vii. p. 153). The new material consists only of a cranium and a pelvis of a Babinga (Akka) woman from the left bank of the Middle Sangha River, about 3° S. The estimated capacity of the cranium is 1440 c.c.; this is very great for a Negrillo, being above the average of European females. Sir W. William Flower's female Akka had a capacity of only 1072, and his female Andamanese averaged 1128; 1200 c.c. is the upper limit of nannocephaly as adopted by Virchow and Kollmann. The skull is very dolichocephalic (73·2), very platyrhine (65·3), mesoseme (87·8), and has a considerable sub-nasal prognathism. These indices agree much more closely with Flower's male Akka (74·4, 63·4, 82·9) than with his female (77·9, 55·3, 82·9). The pelvis is very remarkable; so far as the form and dimensions of the brim are concerned, it is very European, but the height closely approaches that of the negress. Unfortunately there are no data from which the stature could be estimated, but the dimensions of the cranium and pelvis do not indicate pigmy dimensions; and with all due deference to Dr. Verneau, we prefer to await further evidence before accepting this as a typical dolichocephalic Negrillo.

WE have received volume iii., No. 6, and volume iv., No. 1, of that useful publication, *Indian Museum Notes*, which bids fair to rival the valuable American publications on economic entomology, upon which it is modelled. It is freely illustrated with both plates and woodcuts of destructive beetles, butterflies, moths, locusts, &c; but perhaps the most important paper in the parts before us is Mr. E. E. Green's preliminary "Catalogue of *Coccidæ* collected in Ceylon," of which he has made a special study He enumerates 72 species, 44 of which are described as new, while nearly all the remainder either represent new varieties, or species not previously recorded from Ceylon. When Mr. Kirby published his "Catalogue of the described *Hemiptera Heteroptera* and *Homoptera* of Ceylon," in the *Journal* of the Linnean Society, vol. xxiv., in 1891, he was only able to enumerate seven species of *Coccidæ* as known to occur in Ceylon. Any entomologist who cares to take up the study of a little-known group of foreign insects (or even some of the less-studied families of the smaller British insects, for that matter), may reasonably expect to be able to increase our entomological knowledge by leaps and bounds.

G. BREDDIN has published an interesting article on mimicry in *Rhynchota* in the *Zeitschrift für Naturwissenschaften*, vol. lxix., parts 1 and 2 (pp. 17–46, pl. 1). Most of the cases of insect mimicry previously recorded have been observed among *Lepidoptera*, *Coleoptera*, and *Orthoptera*; for though those presented by *Rhynchota* are equally interesting, that order is at present much neglected by entomologists. Several instances, however, were recorded by Reuter in a paper published, in 1879, in *Ofversigt af Finska Vet. Soc. Förh*, vol. xxi. This paper being in Swedish, has attracted little notice, though the late Dr. Haase made some use of it in his well-known work on mimicry. Breddin, therefore, gives a compendium of the observations of Reuter and others on mimicry in *Rhynchota*, including the results of his own investigations. He defines two forms of mimicry—protective and aggressive—the first to avoid attack, and the second to mask it, of each of which he gives numerous examples, drawn mainly, though not exclusively, from the order *Rhynchota*. The aggressive mimicry of the carnivorous masked bugs (*Reduviidæ*) and their allies is specially noticeable, and attracted the attention of many of the earliest entomologists. Those interested in mimicry will find Breddin's article

important; but it involves so much detail that a full abstract, short of a complete translation, is impracticable. It concludes with a short list of characteristic flower-frequenting beetles, by H. Hahn and P. Breddin-Magdeburg. On the coloured plate which illustrates this paper, the figures representing species of the curious Homopterous genus *Umbonia*, which resemble large thorns, are specially remarkable.

MR. W. E. NICHOLSON'S translation of the treatise in which Dr. Weismann described and discussed "New Experiments on the Seasonal Dimorphism of Lepidoptera," is concluded in the August number of the *Entomologist*. It may be remembered that the same journal published during last year a translation, by Dr. Dixey, of Dr. Standfuss's paper on the effects of artificial conditions on the development of butterflies (see NATURE, vol. liii. p. 540), and this translation, together with the one of which the publication is just completed, will doubtless be highly valued by British entomologists unacquainted with the German language. The concluding paragraph of Weismann's paper, in its English form, reads as follows: "We may now at any rate go so far as to say that the temperature *before* pupation has no influence on the colour and marking of the perfect insect. My experiments with *phlæas* already pointed to this, in so far as in this case the larvæ which hatched from Neapolitan eggs produced very different butterflies, although the pupæ only had been subjected to different temperatures, but the larvæ were all treated exactly alike. Merrifield has shown for *Ennomos autumnaria*, that the very different temperatures in which the larvæ may be reared are without influence on the colouring of the perfect insect. Therefore although, as we have recently learnt, the form of the wings of the imago is outlined very early in the larva, yet the decision as to which of two wing-determinants of an adaptively seasonally dimorphic species shall become active is, at the earliest, given at the beginning of the pupal period."

THE resources of bacteriology are seemingly inexhaustible, and its beneficent applications as varied as they are comprehensive, whilst investigations of theoretical interest are daily assuming a practical importance hardly dreamt of by their original discoverers. Little did Hellriegel, Wilfarth, and Beyerinck imagine that when they announced that certain leguminous crops are able by means of root-nodules to fix the free nitrogen of the atmosphere, and that this was accomplished by the aid of particular bacteria contained in such nodules—little did they anticipate that a few years later the great German firm of colour-manufacturers, Messrs. Meister, Lucius, and Brüning, at Höchst-am-Main, would undertake to deliver, as an article of commerce, cultivations of such bacteria under the name of *Nitragin*, wherewith to inoculate, and so supply the wants of, various leguminous crops. This is, however, what Dr. Nobbe, the distinguished follower in the footsteps of Hellriegel, has rendered by his brilliant researches an accomplished fact. Pure cultivations of nodule-organisms suitable to the growth of no less than seventeen different varieties of leguminous field crops may now be purchased from this enterprising firm. Each bottle bears a different coloured label according to the crop for which it is destined, whilst the German as well as the botanical name of the plant is also affixed. About half an acre of land may be inoculated for half-a-crown, which represents the price of a single culture bottle. The cultivations are prepared at the Höchst Works, under the direction of a former assistant to Dr. Nobbe, and the result of this latest development of practical bacteriology will be awaited with the greatest interest. Meanwhile the English Government, whilst contemplating extensive financial assistance to the agricultural interests in the country, might do well to consider whether more lasting benefit to the community might not be derived from the better endowment of science in our local colleges, and the encouragement of original research. It is the lack of this support, which in Germany is fostered so jealously, that handicaps the work, and places the worker at such a great disadvantage when compared with our more fortunate continental neighbours.

WE have received from the Deutsche Seewarte, Hamburg, a circular setting forth proposals on various questions to be raised by it at the Meteorological Conference in Paris, in September next (1) on the improvement and simplification of the exchange of weather telegrams over Europe. The introduction of the circuit-system of telegraphy, which already exists in the United States, would greatly accelerate the arrival of weather reports. Also the omission of certain details, such as the readings of wet-bulb thermometers, and maximum and minimum temperatures, not being of great importance in the preparation of weather forecasts, would lessen the cost of telegrams. (2) Uniformity of hours of observation. At present, differences of time of from one to two hours exist between the observations of different countries. So far as this country is concerned, the proposal is to take observations at 7h. a.m. instead of 8h. a.m. To carry out this recommendation, it would be necessary to open many provincial telegraph stations specially for the weather reports, as generally they do not open till 8h. a.m. Greenwich time; and in Ireland, where Dublin time is used, the offices would have to be opened still earlier. (3) Extension of the international system of meteorological publications, by means of monthly reports, and five yearly *résumés*: the investigation of the anomalies of pressure and temperature to appear only in the year-books. (4) Instruction in meteorology in schools and universities. (5) Comparison of the various sunshine recorders, and uniform instructions for the observation and exposure of the instruments. The instruments mostly in use are Jordan's photographic recorder, and the Campbell-Stokes frame and glass sphere in which the sun scorches a trace on prepared paper. (6) Maritime Meteorology. The Deutsche Seewarte will present two special papers to the Conference on the discussion and utilisation of observations made at sea.

THE Report of the Botanical Department of the State Agricultural College for Michigan is chiefly occupied by a list of the hardy plants, 1335 in number, grown in the Botanic Garden. It also contains a report of the present condition of the Herbarium (42,861 species of Flowering Plants), and some notes on Forestry.

A LARGE portion of *Botany Bulletin*, No. 13, of the Department of Agriculture, Brisbane, is occupied by a descriptive paper on the Chemistry and Economic Products of a number of Queensland Gums and Resins, by Dr. J. Lauterer. It also contains descriptions of a number of new Queensland flowering plants; additions to the Mosses, Hepaticæ, Lichens, and Fungi of the colony; and two additions to the Flora of New Guinea.

THE Helmholtz Memorial Lecture, delivered by Prof. G. F. Fitzgerald before the Chemical Society in January last, is printed in the July number of the Society's *Journal*, with a heliogravure portrait of the great investigator in honour of whom the lecture was given. It would be difficult to compose a better appreciation of a man's contributions to science than that contained in Prof. Fitzgerald's discourse.

IN another part of this issue (p. 329) will be found a notice of the fifth of an attractively produced series of reprints of old meteorological papers, edited by Dr. Hellmann. The sixth of these, "Neudrucke von Schriften und Karten über Meteorologie und Erdmagnetismus," is a facsimile reprint of Hadley's paper "Concerning the Cause of the General Trade-Winds," published in the Royal Society's *Transactions* in 1735. The paper occupies little more than four pages of the publication, but Dr.

Hellmann makes up for its slenderness by means of a short biography of Hadley, and several helpful and interesting notes. The reprints are published by Messrs. A. Asher and Co.

THE *Journal of Botany* reprints some very interesting extracts from Mr. T. Kirk's presidential address to the Wellington (New Zealand) Philosophical Society, on the displacement of native by introduced species of plants. Next to man, the chief agents in this destructive work in New Zealand are sheep and rabbits, but the black rat has also had his share. "Some districts are eaten almost bare by these close feeders, little being left except the tough bases of *Poa cæspitosa* and the wiry ligneous stems of *Mühlenbeckia*, and similar plants; even the woolly leaves of some species of *Celmisia* are often closely cropped, the result being that the more delicate plants are all but extirpated over large areas." Introduced plants like *Silene anglica*, *Erigeron canadensis*, *Rumex obtusifolius* and *crispus*, *Bromus sterilis*, and *Holcus lanatus*, have almost driven out the original littoral vegetation in some districts. Even more destructive are the ravages caused by the parasites, animal and vegetable, which some of these strangers bring with them. Some idea of the extent of this invasion may be gathered from the fact that the first catalogue of naturalised plants in New Zealand, published in 1855, comprised forty-four species; while at the present time Mr. Kirk is himself acquainted with 304 species, while others put the number at 382.

WE have received the first number of vol. iii. of *Poggendorff's Biographisch-Literarisches Handwörterbuch der Exacten Wissenschaften* (J. A. Barth, Leipzig), which is to contain short biographical notices of mathematicians, astronomers, physicists, chemists, mineralogists, geologists, geographers, &c., living within the period 1858–1883. The first number extends from "d'Abancourt" to "Beilstein," and the whole volume will contain about fifteen numbers, appearing at intervals of six weeks (3*s*. each). The times preceding 1858 have already been dealt with in the first and second volumes (price 28*s*.), and any gaps which have been discovered since will be filled up in the present volume. A fourth volume is to cover the years from 1883 to 1900. The whole work will be a monument of careful compilation, and will do much to unify the world of science. The plan of the work is admirably designed. Short biographical notices are followed by a detailed enumeration of the papers and books contributed to scientific literature. Among the men of this first number, Sir G. B. Airy is *facile princeps* in the volume of his writings, as the four closely-printed columns of titles testify. There are many Arabian and other philosophers who are now seldom heard of, such as Abraham ibn Esra of Toledo, Al Marokeschi of Marocco, and Al Mahani of Khorasan, which this dictionary preserves from unmerited oblivion. Taken as a whole, the dictionary appears to be highly trustworthy, and the print and paper leave nothing to be desired.

IN the current number of the *Comptes rendus* there is an account, by M. H. Moissan, of some further experiments on the preparation of the diamond. With the view of obtaining the greatest possible pressure upon the solution of carbon in iron during solidification, the cooling with mercury or other metal was arranged in such a manner that small spheres from 5 mm. to 10 mm. in diameter were produced. These spheres gave specimens both of the black and transparent varieties of diamond, which, although very small (0·01 to 0·02 mm.), were remarkably regular and perfect in shape, agreeing exactly with the forms found in nature.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mr. V. Lloyd; two Amaduvade Finches (*Estrelda amandava*) from India, a Paradise Whydah Bird (*Vidua paradisea*) from West Africa, presented by Miss M. von Laer; a Raven (*Corvus corax*), British, presented by Mr. A. H. Cullingford; a Martinique Gallinule (*Ionornis martinicus*) from South America, presented by Mr. A. W. Arrowsmith; a Cape Viper (*Causus rhombeatus*), a Puff Adder (*Vipera arietans*), a Cape Bucephalus (*Bucephalus capensis*), five Hoary Snakes (*Coronella cana*), a Ring-hals Snake (*Sepedon hæmachates*), four Crossed Snakes (*Psammophis crucifer*), six Rufescent Snakes *Leptodira rufescens*), three Rough-keeled Snakes (*Dasypeltis scabra*), four Rhomb-marked Snakes (*Psammophylax rhombeatus*), a Delaland's Lizard (*Nucras delalandii*), a Defenceless Lizard (*Agama inermis*) from South Africa, presented by Mr. J. E. Matcham; four Midwife Toads (*Alytes obstetricans*), South European, presented by Prof. Gustave Gilson; a Gentoo Penguin (*Pygosceles tæniatus*) from the Falkland Islands, deposited; eight Amherst Pheasants (*Thaumalea amherstiæ*), two Peacock Pheasants (*Polyplectron chinquis*), two Himalayan Monauls (*Lophophorus impeyanus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE PLANET SATURN.—In the *Astronomische Nachrichten*, No. 3365, Prof. Barnard comments upon the accounts of various new markings on the rings and body of this planet. In company with Profs. Burnham and Hough, he carefully examined Saturn with the 18½-inch refractor at Dearborn Observatory. The planet was in a good position for seeing, being on the meridian, and during the evening several difficult double-stars were accurately measured. In spite of this, no abnormal features could be discerned, either on the globe or on the rings. The recently reported observations of new divisions, ragged edges to the crape-ring, &c., were all invisible. In fact the planet appeared very similar to what Prof. Barnard usually saw with the 36-inch Lick, although the latter, with its larger aperture, made the identification of details less difficult.

NEW NEBULOSITY IN THE PLEIADES.—W. Stratonoff, in the *Astronomische Nachrichten*, No. 3366, describes the results of recent long-exposure photographs of the Pleiades, taken with a refractor of 13 inches aperture. Three photographs are mentioned, obtained with exposures of 9h. 54m., 17h. 36m., and 25h. The first two show most of the known nebulosity, but the third shows the existence of several new features. The chief of these is a long straight streak of nebulosity extending from $\alpha = 3h.\ 40{\cdot}7m.$, $\delta = +24°\ 4'$ to $\alpha = 3h.\ 41{\cdot}9m.$, $\delta = +24°\ 4'$, roughly about 20′ north of Alcyone. The breadth of this is from 20″ to 30″; it is almost parallel to the neighbouring line of nebulosity described by M. M. Henry, and has a very similar form.

Another slight nebulosity is visible on the plate near the star 18m., in the form of several filaments lying north and south, and varying in breadth from one to three minutes of arc.

NEW VARIABLE IN HERCULES.—Mr. T. D. Anderson, of Edinburgh, gives in the *Astronomische Nachrichten*, No. 3366, a description of his observations of a 9th magnitude star, leading to the discovery of its variability. This is the star B.D. + 27°·2772, whose position for 1855·0 is given as R.A. = 17h. 4m. 58·4s., Decl. + 27° 14′·3. The star could not be found in September 1895, using a 2¼-inch refractor, but in October of the same year it was easily seen with the same instrument. Taking two neighbouring stars of magnitude 8·8 and 9·6 for comparison, he found the variation in magnitude to be from 9·2 to below 10 in about a month. In July 1896 he again found the star to be invisible as in September 1895, although the neighbouring 9·6 magnitude star was easily seen again.

THE INSTITUTION OF MECHANICAL ENGINEERS.

THE annual summer meeting of the Institution of Mechanical Engineers was held last week in Belfast, commencing on Tuesday, July 28, and concluding on Friday, July 31. There were two sittings for the reading and discussion of papers, the following being a list of those presented:—

"Flax Scutching and Flax Hackling Machinery," by John Horner, of Belfast.

"Electric Lighting in Belfast," by Victor A. H. McCowen, Electrical Engineer to the Belfast Corporation.

"Unusual Corrosion of Marine Machinery," by Hector MacColl, of Belfast.

"Rope Driving," by Abram Combe, of Belfast.

"Description of the Belfast Gas Works," by James Stelfox, Engineer and Manager.

"Description of the Alumina Factory at Larne Harbour," by James Sutherland, Manager.

"Partially immersed Screw-Propellers for Canal Boats; and the influence of Section of Waterway," by Henry Barcroft, of Newry.

The last paper was not read.

On members assembling on Tuesday, July 28, in the Examination Hall of Queen's College, Belfast, addresses of welcome were given by the Lord Mayor of Belfast, Mr. Pirrie, and by Mr. W. H. Wilson, the chairman of the Reception Committee. After this the chair was taken by the President, Mr. E. Windsor Richards, and the first paper was read.

This was Mr. Horner's contribution on flax scutching and flax hackling machinery. It was illustrated by a number of wall diagrams, without the aid of which it would be impossible to describe the intricate mechanism used in the flax industry. It is a task we will not attempt. A point of economic interest which came out in the discussion may, however, be referred to. A gentleman connected with the industry pointed out the lamentable waste that occurs owing to the unsatisfactory methods of scutching followed in Ireland. It appears that the flax-growers are always more anxious to get their money quickly for their produce than to get a full return. To scutch flax properly requires time, and also more costly machinery than is generally used in Ireland. On the continent the growers are more far-sighted, and have a larger command of capital; at any rate they have superior machines, which are more expensive at first cost, and, moreover, take a longer time in performing the operations. The foreign growers have their reward. The yield is 20 to 25 per cent. greater than with the Irish machines; and though it costs about double as much to scutch a given quantity of flax on the continental system, the yield is so much greater that a far larger profit is ultimately obtained. We gathered also from subsequent visits to the flax mills in Belfast that the continental flax is much preferred by the manufacturers, being cleaner and more easily worked. One would be inclined at first sight to attribute these facts to the conservative and shortsighted methods of the people of this country; for we are very prone to accuse ourselves of errors of this kind. It may be some satisfaction, therefore, to persons of a cynical disposition to find that the generally astute Americans are guilty of a similar fault. Mr. Dobson, of Bolton, a well-known maker of cotton-spinning machinery, told the meeting that there was an immense loss in the preparation of raw cotton, due to the very primitive ginning machinery used by the cotton-growers. It is evident that both here and in America we have something to learn from the more frugal and painstaking flax-farmers of the continent of Europe.

Mr. McCowen's paper on the electric lighting in Belfast followed. The chief feature of interest in the Belfast installation is the fact that all the prime movers are gas engines. Six of these are on the Hartley and Kerr system. They are supplied by Dick Kerr and Co., of Kilmarnock. Four are double acting, with the cylinders working tandem-wise, and having two pistons on the same rod. These engines run at a speed of 160 revolutions per minute, and indicate 120 h.p. The number of explosions per minute is 320 or 330, or 2 per revolution. The remaining two of the six gas engines are single cylinder and double acting. They also run at 160 revolutions, and indicate 60 h.p. The number of explosions per minute is 160, or one per revolution. Naturally the cyclical variation in speed of the tandem engines is very small, owing to the number of explosions, their low initial pressure, and their even distribution; the number of explosions being four to one, in comparison with the single cylinder, single acting engine; there being four complete Otto cycles in two revolutions. The method of governing is worthy of attention, as being different from that usually adopted of missing an explosion. The impulses are continuous, and the supply of gas is graduated per stroke according to the load. The quantity of air supplied to the cylinder is practically constant, the quantity of gas only being varied. This under ordinary cases would lead to a difficulty of ignition. As is well known, a poor mixture of gas and air ignites slowly; but it is said that stratification takes place in the cylinder. Taking advantage of this, gas is admitted to the cylinder later and later in the charging stroke; although even at full power a considerable quantity of air is drawn into the cylinder before gas is taken in. The full supply of air almost immediately follows the piston, while there is only a small portion of rich and explosive mixture near the ignition chest. It will be easily understood that the mechanism by which the somewhat novel operations are carried out is of an interesting nature. It was explained by the author by means of wall diagrams; but in the absence of these we can only refer our readers to the published transactions of institutions in which the diagrams will be reproduced.

These slower running engines drive the dynamos by rope-gearing, but there are two smaller engines of the high speed vertical type, manufactured by the Acme Gas Engine Company of Glasgow. They have four single-acting cylinders arranged in two lines of two in tandem, working on to opposite cranks. At full speed they run at 380 revolutions per minute. In the paper tables were given detailing the various conditions of running, quantity of gas used, &c. Without going into the details of these tables, it may be stated that the efficiency of the tandem engines does not appear to be very high, 27·4 cubic feet per electrical h.p. per hour being the best result. This, of course, could be beaten by an engine running on the Otto cycle; but we must remember that for electric lighting purposes the Otto cycle, with its one impulse in four strokes, is not well adapted unless an enormously heavy fly-wheel be used. It is the old problem that so often faces the engineer: to get efficiency in one direction something has to be sacrificed in another; and, so far as electric lighting is concerned, the engineer apparently has to choose between an increased consumption of gas, or the prospect of unsteady lights. From experience we can say that the Belfast station gives good results if we simply regard the product. But we believe that when an extension of the station is undertaken—as there is every prospect there will be shortly—steam, and not gas, will supply the motive power.

On the second day of the meeting, Wednesday, July 29, Mr. Hector MacColl's paper on the unusual corrosion of marine machinery was read. It appears that a cargo steamer was sunk on the coast of Scotland; she was loaded with "burnt ore," and was under water for a week. On examination, when the vessel was once more floated, the machinery was found to present an extraordinary appearance. All wrought-iron work was deeply and roughly corroded, and planed cast-iron work was rendered so soft as to be easily cut with a knife. As the engines of steamships are generally very little injured by submergence, even for lengthened periods of time, it was evident that there was, as the title of the paper indicated, an unusual cause for this state of affairs. This was found in the cargo. Burnt ore is the residue from the manufacture of vitriol from sulphur pyrites, and is generally found to contain about 4 per cent. of sulphate of copper, together with a little sulphate of iron, due to the sulphur not having been completely burnt out of the ore and becoming oxidised with sulphates. The sulphate of copper would be more or less completely dissolved in sea-water; and, as the latter contains a considerable quantity of chloride of sodium, this would react on the sulphate of copper, forming sulphate of sodium and chloride of copper. The sulphate of copper and chloride of copper are both soluble in water, and a solution of either or both dissolves wrought-iron and cast-iron. The chloride is more energetic in its action than the sulphate; but in time a solution of either, no matter how weak, will dissolve an atom of iron for every atom of copper present. If is satisfactory to know that the author was able, notwithstanding the great apparent damage done, to put the engines and boilers into working order again, and the ship is now doing duty on the high seas.

The next paper was perhaps the most important read at the meeting; it was Mr. Abram Combe's contribution on rope driving. As is fairly well known, Belfast is the home of rope driving as a means of conveying power from motor to machine; so far, at any rate, as mill purposes are concerned. The inventor was Mr. James Combe, of the author's firm of Combe, Barbour, and Combe, who are very large manufacturers of flax-spinning machinery. This gentleman in 1856 applied an expanding pulley with V-shaped sides to the differential motion of flax and tow roving frames, conveying the power by means of a round leather rope. He was struck by the efficiency of this gearing, and this led him to try the application of the same

means of transmission to larger power. As a result of a number of experiments he found that the following were the best ratios of diameters for ropes and pulleys :—

1¼ inch diam. rope	3 feet diam. pulley	ratio	1 to 28·8
1½ ,, ,,	4 ,, ,,	,,	1 to 32·0
1¾ ,, ,,	5 ,, ,,	,,	1 to 34·3
2 ,, ,,	6 ,, ,,	,,	1 to 36·0

In regard to power transmitted, it was found that when working under ordinary conditions the foregoing sizes of rope transmit, for each 100 revolutions per minute made by the pulley, the following :—

Rope 1¼ inch diam.	on 3 feet pulley	would give	5 I.H.P.
,, 1½ ,,	4 ,,	,,	8 ,,
,, 1¾ ,,	5 ,,	,,	11 ,,
,, 2 ,,	6 ,,	,,	15 ,,

These figures may be exceeded under more favourable circumstances. The best angle of the groove on the pulley was found to be 45°, and the best speed of rope 3300 feet per minute. Illustrations and descriptions were given of many very ingenious forms of rope driving, by which power was conveyed from a driver to a single driven pulley under conditions that would have been impossible with belts, or in any case unless complicated trains of wheel gearing had been employed. In the discussion which followed the reading of this paper, a good deal of light for the uninitiated was thrown on rope driving practice. The importance of splicing was brought to the fore, and on this depends to a large extent the durability of ropes used for conveying power. A short splice will not do at all, and even the "long splice" ordinarily made by the mariner is insufficient. For 3-inch ropes the splice has to be 12 feet long; the strands being cut and divided, so as to avoid producing what sailors call a "gouty" length; that is, one where there is an increased diameter. Three patterns of rope are used; the three strand, four strand, and the served rope. The former is far the easier to splice, the latter the most difficult. A served rope, however, has the greatest flexibility; a very prominent virtue in a driving rope, as it leads to longevity, and enables smaller pulleys to be used without ill effect. In regard to material, cotton appears to be the favourite. It is almost universally used in England; naturally so in the Lancashire district, where rope-driving practice is so largely followed. In Ireland manilla appears to be most often used. There was one speaker, who came from India, and who said that he had used coir rope with great success; this is made from the fibrous material of the husk of the cocoanut. We should have thought this substance would have been altogether too elastic for the purpose. Another speaker, Mr. McLaren, had used rope-driving for ploughing purposes, but had gone far beyond the proportions advised by the author in his table. For instance, he had used a ¾-inch rope to transmit 40 horse-power, whilst his pulleys were no more than 20 inches in diameter. This rope we understood him to say was a manilla one, but the proportions seem altogether extraordinary. We should have thought a wire rope would have been more likely to answer the purpose. The speaker, however, drew the moral that too high a factor of safety was demanded by engineers in rope driving. Later on Prof. Goodman stated that he had calculated the average factor of safety in rope driving at about 90 per cent.

One of the excursions during the meeting was made from Belfast to Larne Harbour, to visit the alumina factory there situated. A description of this factory formed the basis of Mr. Sutherland's paper. Although, as is universally known, aluminium is one of the most abundant metals found in the earth, there are not many of the compounds containing it which render themselves readily to the extraction of the metal. Bauxite is the one generally used for its production, and large deposits of this have been found in County Antrim. The analysis is as follows:—Alumina is 56 per cent., corresponding to aluminium 29·9 per cent., peroxide of iron 3 per cent., silica 12 per cent., titanic acid 3 per cent., water 26 per cent. The peroxide of iron, silica, and titanic acid have to be separated out before the extraction of the metal from the alumina is attempted; and it is the function of the Larne works to carry on these operations; the smelting of the ore being done by electrical methods at Foyers. That, however, is an operation which does not come within the scope of the paper now before us, but may form the subject later on of another contribution in the transactions of the institution.

It is the Bayer process which is used at Larne. The bauxite, as received from the mines, is first ground and sifted, after which it is taken to a calciner in order to remove the organic matter present, which would prevent the subsequent separation of the alumina from the caustic soda. The calciner is an iron tube lined with fire-brick, and caused to revolve on rollers. It is inclined at a necessary angle, the heat from the furnace passing up through the tube. As the tube inclines, the bauxite travels to the lower end, and falls out into a receptacle. The alumina is extracted from the ground bauxite by treating it with a strong solution of caustic soda under pressure. This operation is carried out in Kiers. A soluble compound of alumina and soda (aluminate of soda) is thereby formed, while the peroxide of iron, silica, and titanic acid remain as an insoluble compound. The Kiers are steam-jacketed, and have paddles mechanically actuated to agitate the mixture. The steam pressure in the jacket is carried up to 70 or 80 pounds, and the mixture is subjected to the heat corresponding to the pressure for two or three hours until decomposition is complete. The liquid product of the Kiers is then passed through filter presses, the impurities being insoluble are retained, while the liquid aluminate runs into tanks. The residue, or cakes of impurities, are afterwards washed to extract as much of the aluminate of soda as possible; and the washings are used for diluting the product of the Kiers. Centrifugal pumps are employed for this purpose. At present the red mud forming the residue is useless, and there is an opportunity for any chemist to suggest a means by which it could be utilised. Experiments are being conducted in this direction by the Company. The lyes from the presses contained in the filter tank are afterwards subjected to another filtering process, being passed through cellulose, consisting of paper-makers' pulp. About fifty pounds of cellulose is boiled with water to a thin pulp, and is run upon sieves; it soon settles down, and is then ready to receive the lyes, arresting all finely divided, insoluble particles that have escaped from the filter presses. Finally, there is another filtering process.

It is now necessary to separate the alumina from the soda. This is brought about by the addition of excess of more hydrate of alumina to the hydrate of alumina itself, and in this way about 70 per cent. of the alumina in combination with the soda separates out in thirty-six hours. The hydrate of alumina is then pumped out of the decomposing cylinders, in which the latter process has taken place, sufficient however being allowed to remain behind in the cylinder for beginning the decomposition of the next charge of liquor admitted. The hydrate of alumina pumped out is filtered through filter-presses, and the last traces of soda are removed by washing. The hydrate of alumina is then taken to the calcining furnace, where the water of hydration is driven off at a low temperature, leaving the alumina perfectly anhydrous. It will, however, take up water again readily, and to prevent this it is heated to about 2000° F., when it becomes crystalline, and not so liable to absorb moisture. The weak soda liquors which are obtained are concentrated by a triple-effect evaporator.

On the afternoon of Wednesday he members and their friends were shown these processes in operation at Larne.

The last paper read was that by Mr. Stelfox. It was not discussed, the time for the conclusion of the meeting having arrived.

The Belfast meeting was a complete success, the whole arrangements being carried out most satisfactorily. A large number of the works of Belfast were visited by members, manufacturers being most liberal in opening their establishments to members, and generally showing that hospitality for which Ireland is renowned. The summer meeting of next year is to be held in Birmingham, the city in which the Institution of Mechanical Engineers had its origin fifty years ago next year.

OLD WORLD METEOROLOGY.[1]

IN the year 1508 a book was published in Germany under the title of the "Bauern-Pracktik." This book had a wide circulation. It taught the farmer, the sailor, the merchant—all, indeed, who were interested in the weather—what would be its

[1] "Die Bauern Praktick. Neudrucke von Schriften und Karten über Meteorologie und Erdmagnetismus." Herausgegeben von Prof. Dr. G. Hellmann. (Berlin: A. Asher and Co., 1896.)

character, not only for the coming year, but in all future years. This book, with its many editions and translations, has now become very scarce, and a facsimile copy of the original has been reproduced by Prof. Hellmann, who, with the affection of the ardent bibliographer, has traced it with infinite difficulty through many libraries and into many unexpected places. To this little book, which consists of only eight or nine pages, the editor has added an introduction of some seventy, bearing the same relation to the original work that Falstaff's sack did to his bread. And just as Falstaff found his bread an unwelcome addition, so these last few pages are a hard nut to those who have not made a critical study of the German of the fifteenth century. But Prof. Hellmann's introduction gives great assistance, and by the help of it we have made out some of the rules and predictions, which appear quite as trustworthy as the prognostications that our modern weather prophets circulate, and in which no doubt they find their account.

The proper title of the book appears to be "In disem biechlein wirt gefunden der Bauren Pracktick unnd regel darauff sy das ganz iar ain auffmercken haben unnd halten." Under this title is a woodcut of a figure contemplating a crucifix, the whole surrounded by a scroll-work not badly executed. The text can be conveniently divided into three parts. The first shows how the weather, the harvest, the crops, and so forth, can be predicted from observations of the weather at Christmastide. If the weather is fair and clear on Christmas night, then there will be plenty of wine and fruit. If the weather be contrary, so will the matter fall out contrary. Then the wind is of importance. We understand the author, whoever he may be, to say that if the wind gets up at sunrise the year will be dear; but if the wind gets up at sunset, the king and the great lords will die. Like our modern prophets, the author is not afraid to indicate the course of political events. A fruitful year is foreshadowed by a west wind at midnight, but a southerly wind at midday betokens that there will be daily thunder. The author's word is "Krackhair," but whether we are justified in tracing it to "Krachen" must be decided by the student of old German. One can only regret that, with so simple a rule for his guide, one should be hindered from getting the full benefit, by his ignorance of the language in which it is written.

Then the author goes on to tell us what will happen when Christmas day falls on a Monday, Tuesday, and so on to Saturday; a very simple cycle, a little disturbed by the introduction of leap years, but nevertheless of great value to simple folk. With Christmas day on Sunday, among other things we are told that the summer will be hot and dry and fine, the autumn damp and wintry. There will be plenty of corn and wine and much honey, and if the text be correctly construed it says that "old people will die willingly"; but this seems such a contradiction to known facts, that the German must speak for itself to those who can understand it. "Die alten leüt sterben geren."

This is the kind of information that we get for each of the days of the week, and it is curious to notice the important part that honey plays in the predictions. He kills his king and his princes and his young men and his old women, but through all disasters he evidently remembers his honey, and in his partiality ranks it of equivalent importance to corn and wine.

In the next section we are told what will happen by the condition of the weather during twelve days, presumably between Christmas and Epiphany. The rules are very short, and are given without ambiguity or hedging. If the sun shines throughout Christmas day it indicates a peaceful year; if on the next day, however, money vanishes and corn becomes dear. But the third day presages something so awful that one must hope his translation is at fault. "So kriegen die bischof uñ die prelaten gern /uñ wirt irrung und den pfaffen." The spectacle of bishops, priests and deacons quarrelling is so opposed to our knowledge of their character, that some mistake has evidently glided in here, or the words do not convey the meaning which they apparently do to one only acquainted with modern German.

The book concludes with remarks of similar value on each month more or less depending upon Church festivals, and thus connecting Church observance with meteorological phenomena. This strikes one as an ingenious method of ensuring observance of the Church's calendar. If the sun shines on St. Vincent's day, we are told there will be much wine; if on St. Paul's day, a fruitful year. This last prediction recalls another of probably still older date. "Clara dies Pauli bona tempora denotat anni."

When the book passed over into a French translation a lighter note seems to have been struck, judging from the jingling rhymes by which it is recommended to the reader.

Prognostication nouvelle
Des anciens laboureurs m appelle
Je fus de Dieu transmise aux vieulx
Qui m ont approuvee en tous lieux
Et comme je diray motz a motz
Les anciens ne font pas sotz
Achepte moy quand m auras veu
Car tu ne seras point deceu
Je te donray une doctrine
Qui te vauldra d'or une mine
Et hardiment sur moy te fonde
Car je dure autant que le monde
Et si te veulz bien advertir
Que je ne te veulx point mentir.

The contents appear, however, to be but a translation of the older German work, and the subject is regarded as too sacred and important to allow any license to the playfulness of French wit, to enliven the sobriety and heaviness of the German original.

In our own country, under the title of the "Husbandman's Practice," the book seems to have enjoyed a wide popularity. No divine authority was, however, invoked, but the predictions were fathered upon the astronomers, forsooth, and this too about the time that Newton published the "Principia," and Flamsteed was at work at Greenwich. The preface runs: "The wise and cunning masters in astronomy have found, that man may see and mark the weather of the holy Christmas night, how the whole year after shall be on his working and doing, and they shall speak on this wise."

"When on the Christmas night and evening it is very fair and clear weather and is without wind and without rain, then it is token that this year will be plenty of wine and fruit." And without much alteration or addition the rigmarole is translated from the German. From a remark of Prof. Hellmann, it is to be gathered that the legend of St. Swithin as a guide to the July weather did not appear in the early German editions. It first made its appearance in the English version some time before 1668.

We find it somewhat difficult to take the work of Prof. Hellmann seriously, the predictions are so crude and ludicrous; but it is impossible to read his preface without acknowledging the care and thoroughness with which he has done his work, and the labour he has bestowed upon the subject. The book itself may not be worth a second thought, but Prof. Hellmann has made it serve the purpose of developing two lines of investigation of great interest and importance, into which, however, we cannot adequately enter. In the first place, how are we to account for the widespread hold upon the public mind that such a book had, and for so long maintained as a popular treatise? Whence comes the deep-seated love of the marvellous and superstitious, which manifested itself in many ways, and in particular is connected with the twelve days about the time of the winter solstice, when the days are at their shortest. Prof. Hellmann endeavours with some success to trace evidences in the remote past of the tendency to predict the weather from observations made on these twelve days, each day corresponding to a month in the forthcoming year. That these days have become connected with a Christian festival is to a certain extent an accident of later date.

This observation of the weather about the time of Christmas is brought out more clearly in the second inquiry, when the question of the origin of the book itself is raised, or rather on the authority on which these wise saws rest. Discarding such modern authorship as Heiny von Uri or Thomas von Filtzbach can claim, the editor shows that the book, or at least the contents of it, circulated in a traditional or MS. form long before it took its printed shape. With difficulty he has traced and compared ten MSS., dating back from 1478, all possessing common features indicating a common origin, and pointing out with some degree of plausibility to the pages of the Venerable Bede as the oldest known source. But this wish to penetrate the future, and the formation of rules for general guidance are older than this remote date, and traces of ancient customs and old predictions are to be found in all parts of the globe, wherever written records have been preserved. But there is the curious fact to be remarked, that the older MSS. show a tendency to refer the grounds for prognostication to the Calends of January rather than to the Christmas festival, and in the case of a fifteenth century MS. both are mentioned. Christmas is quite a late innovation, and the growth in importance of the great Christian festival can be traced by its gradual displacement of the older Calendar in these meteorological superstitions.

PRIZES OFFERED BY THE SOCIÉTÉ D'ENCOURAGEMENT

THE *Bulletin* of the Société d'Encouragement pour l'Industrie Nationale contains a list of the medals and prizes to be awarded in 1897 and 1898. Amongst these, the following prizes are proposed for 1897. In the Mechanical Arts: for improved methods in milling of grain (2000 francs); for a motor weighing less than 50 kilogrammes per horse-power developed for use in aerial navigation (2000 francs); for a study of the coefficients necessary for the calculations of an aërial machine (2000 francs); for a small motor suitable for domestic use (2000 francs); for improvements in machine tools (2000 francs).

In the Chemical Arts: for the utilisation of waste products (1000 francs); for a new method of preparing fuming sulphuric acid or sulphur trioxide, which shall be more economical than those at present in use (2000 francs); for a liquid which shall replace sulphuric acid in dyeing, especially of silk, without exercising the same destructive action on the fibre (1000 francs); for a scientific study of the physical and mechanical properties of glass (2000 francs); for the preparation on the large scale of a new alloy of iron possessing specially useful properties (2000 francs).

In the Economic Arts: prizes are offered for the construction of a hydro-extractor that can be worked continuously (2000 francs), and for important improvements in the manufacture of permanent magnets, with especial reference to their stability (3000 francs).

In Agriculture: for a study of alcoholic ferments (3000 francs); for the best study of the diseases of cider and the means of arresting their development (2000 francs); for the best practical means of destroying one of the insect enemies of the vine (1000 francs). There will also be awarded in 1897 a prize of 2000 francs for an economic study of an industrial centre in France, and of 1500 francs for a study of insurance against involuntary want of employment.

The more important prizes offered for 1898 include the Marquis d'Argenteuil prize of 12,000 francs for the discovery of the greatest service in developing French industry; for a publication of service to chemical or metallurgical industry (2000 francs); for an experimental study of the physical or mechanical properties of some metal or alloy in common use (2000 francs); for the invention of new methods of utilising petroleum (0 8 k. or higher) advantageously and without danger, for either manufacturing or domestic purposes (2000 francs); for the best varieties of barley for brewing (1500 francs); for the reconstitution of vineyards upon chalky soils (3000 francs); and for the best study in vine culture in France (2000 francs).

SCIENCE IN THE MAGAZINES.

GLACIALISTS making arrangements for their summer migration to Switzerland, and other geologists interested in ice-work, should read what Dr. A. R. Wallace has to say in the *Fortnightly* on "The Gorge of the Aar and its Teachings," before they set out, and they will then be able to judge for themselves the weight of the conclusions drawn. Dr. Wallace thinks the phenomena presented by the valley of the Aar afford "a fresh and very powerful argument in support of the power of the ancient glaciers both to deepen valleys and to grind out lake-basins," and his article is written to prove the correctness of this view. In the enclosed valley with its two small rock-basins in which the Hospice in the Grimsel Pass is situated, Dr. Wallace sees an example of the effects of a kind of eddy in old ice-streams flowing in nearly opposite directions. The celebrated Aarschlucht, one of the most remarkable gorges in Europe, is from 200 to 300 feet deep, and only about six feet in width. This is held to represent "the result of the action of sub-glacial torrents acting throughout the whole period during which the area was buried in ice. Thus only are we able to explain the fact of the almost uniform narrowness of the gorge from bottom to top, since during the process of its formation the rock walls would be preserved from ordinary denuding agencies, and be kept at a nearly uniform temperature." This view of the origin of the gorge is held by Prof. Bonney and by other geologists who have considered the subject, though the conclusions to which it leads differ. A number of other gorges in Switzerland are similarly explained. Accepting this interpretation, it is evident that gorges of this character ought only to be found in regions which have been recently glaciated. "In our own country," says Dr. Wallace, "we have many small gorges of this character, in Wales, the Lake District, and Scotland, that of Dungeon Gill, in Westmoreland, being an example; but more are to be found in decidedly non-glaciated areas, such as Devonshire, though narrow ravines are common enough. So in the Northern United States there are many such gorges, the Ausible Chasm in the Adirondacks, and Watkin Glen, near Seneca Lake, are well-known tourist resorts; but in the Southern States, beyond the glaciated area, there are no similar gorges, although the southern Alleghenies are loftier than farther north, and contain much grand and picturesque mountain scenery and many waterfalls and deep ravines, but these are all of the rugged and weathered type." In the mountainous region of Brazil, where there has certainly been no recent glaciation, Prof. Branner testifies that none of the characteristic sub-glacial stream channels occur. Finally, the gorges of the Aar, and others of like nature, are shown to afford evidence in favour of the theory of the glacial origin of the Swiss valley lakes. The abrupt Kirchet Hill, which extends across the valley of the Aar, is adduced by Prof. Bonney as an argument against this theory. "This would be a valid objection," says Dr. Wallace, "if the Aar glacier had continued in a straight, or nearly straight, line to Meiringen; but the influx of a large glacier stream from the north-east must have so diverted that of the Aar, that the resultant flow would have been across the lower valley, and almost along the steep face of Kirchet instead of directly across it. This would have been the case, because the glacier stream from the north-east was not only equal in size to that of the Aar valley, but had a more rapid descent, and, therefore, a quicker flow. In the last five miles the Aar valley has a fall of about 1500 feet, while the two north-eastern valleys have an average fall of about 2000 feet; and they are also much wider, which would still further facilitate rapidity of outflow."

Dr. C. M. Aikman gives in the *Contemporary* an account of the inoculation of agricultural land with pure cultures of bacteria, in the form of Nitragin, for the purpose of promoting plant-growth. A note on this advance in the science of agriculture will be found on page 326. To the same review Mr. Andrew Lang contributes a budget of records of the rite of "Passing through the Fire," beginning with the earliest accounts of this or some analogous ceremony, and concluding with the most recent authenticated contemporary examples The rite is very widely diffused, and there is a considerable amount of evidence that the fire-walking is actually practised without apparent injury. In a few villages in Turkey, on the Bulgarian frontier, a festival is held in May, and certain persons still go through the performance of treading and dancing on the red-hot embers of a pile of wood, apparently without sustaining injury. Mr. Lang appeals to men of science to take up the subject, both on account of the widely-diffused religious character of the ceremony, and in order to discover how, granting the facts, the feat is performed. A scientific observer who would go to Bulgaria on May 21 next year, and thoroughly investigate the rite there, noting the state of the fire, the condition of the feet of the ministrants before and after the performance, and photographing the scene, would obtain some definite and valuable information.

A brief mention must suffice for the remaining articles on scientific topics in the magazines received by us. The second part of an historical study, by Mr. J. F. Hewitt, entitled "How the first Priests, the long-haired Shamans, and their successors, the tonsured Barber-surgeons, measured Time," appears in the *Westminster Review*. The article contains many facts of interest as to the origin of the year in the northern and southern hemispheres. The *Century* publishes some glimpses of life in Africa, from the journals of the late Mr. E. J. Glave, who completed his remarkable journey across Africa from east to west in May 1895, and died while waiting for the departure of the homeward steamer. The *Strand Magazine* has a detailed account of the balloon, accessories, and plan of Mr. Andrée, for his aërial polar expedition. There is also a liberally illustrated account of the methods and results of Röntgen photography, by Mr. Alfred W. Porter, in the same magazine. An instructive article on "Atmospheric Pressure" is contributed to *Longman's Magazine* by Mr. H. Harries. Articles of a like character appear in *Chambers's Journal* on "The Glastonbury Lake-Dwellers," and "Work in Compressed Air."

THE REPRODUCTION OF DIFFRACTION GRATINGS.[1]

I HAVE first to apologise for the very informal character of the communication which I am about to make to the club; I have not been able to put anything down upon paper, but I thought it might be interesting to some to hear an account of experiments that have now been carried on at intervals for a considerable series of years in the reproduction—mainly the photographic reproduction—of diffraction gratings. Probably most of you know that these consist of straight lines ruled very closely, very accurately, and parallel to one another, upon a piece of glass or speculum metal. Usually they are ruled with a diamond by the aid of a dividing machine; and in late years, particularly in the hands of Rutherfurd and Rowland, an extraordinary degree of perfection has been attained. It was many years ago—nearly twenty-five, I am afraid—that I first began experiments upon the photographic reproduction of these divided gratings, each in itself the work of great time and trouble, and costing a good deal of money. At that time the only gratings available were made by Nobert, in Germany, of which I had two, each containing about a square inch of ruled surface, one of about 3000 lines to the inch, and the other of about 6000. It happened, accidentally, that the grating with 3000 lines was the better of the two, in that it was more accurately ruled, and gave much finer definition upon the solar spectrum; the 6000-line grating was brighter, but its definition was decidedly inferior; so that both had certain advantages, according to the particular object in view.

If it comes to the question of how to make a grating by photography, probably the first idea to occur to one would be that it might be a comparatively simple matter to make a grating upon a large scale, and then reduce it by photography; but if one goes into the figures, the project is not found so promising. Take, for instance, a grating with 10,000 lines to the inch; if you magnified that, say, 100 times, your lines would then be 100 to the inch; if you magnified it 1000 times, they would still be 10 to the inch, and that would be a convenient size, so far as interval between the lines was concerned; but think what would be the area required to hold a grating magnified to that extent. By the time you have magnified the inch by 100 or 1000, you would want a wall of a house or of a cathedral to hold the grating. If the problem were proposed of ruling a grating with 6000 lines to the inch, with a high degree of accuracy, it would be easier to do it on a microscopic scale than upon a large scale, leaving out of consideration the difficulty of reproducing it. And those difficulties would be insuperable, because, although with a good microscopic object-glass it would be easy to photograph lines which would be much closer together than 3000 or 6000 to the inch, yet that could only be achieved over a very small area of surface—nothing like a square inch; and if it were required to cover a square inch with lines 6000 to the inch, it would be beyond the power, not only, I believe, of any microscope, but of any lens that was ever made. So that that line of investigation does not fulfil the promise which at first it might appear to give; and, in fact, there is nothing simpler or better than to copy the original ruled by a dividing engine, by the simple process of contact printing.

For this purpose some precautions are required. You must use very flat glass, by preference it should be optically worked, although very good results may be obtained on selected pieces of ordinary plate. Of course, no one would think of making such a print by diffused daylight; but the sun itself, or a point of light from any suitable source, according to the nature of the photographic process which is adopted, permits quite well of the reproduction of any grating of a moderate degree of fineness. I have used almost all varieties of photographic processes in my time. In the days when I first worked, the various dry collodion processes were better understood than they are now; the old albumen process was extremely suitable for such work as this, on account of the almost complete absence of structure in the film, and the very convenient hardness of the surface, which made the finished result comparatively little liable to injury. I used with success the dry collodion processes, the tannin process among others, and also some of the direct printing methods, such as the collodio-chloride. The latter method, worked upon glass, gave excellent results, particularly if the finished print was treated with mercury in the way commonly used for intensification, except that, in the treatment of a grating with mercury, it is desirable to stop at the mercury, and not to go on to the blackening process used in the intensification of negatives. From the visual point of view, the grating, after intensification—if one may use the term—with mercury, looks much less intense than before, but, nevertheless, the spectra seen when a point or slit of light is looked at through the grating become very much more brilliant.

I used another process at that time, more than twenty years ago, which gave excellent results, but had not the degree of certainty that I aimed at, namely, a bichromated gelatine process, similar to carbon printing, except that no pigment was employed. A glass plate was simply coated with bichromated gelatine of a suitable thickness—and a good deal depended upon hitting that off correctly; if the coating was too thin the grating showed a deficiency of brightness, whereas, if it was too thick, there might be a difficulty in getting it sufficiently uniform and smooth on the surface. However, I obtained excellent gratings by that process, most of them capable of showing the nickel line between the two well-known sodium or D lines in the solar spectrum, when suitably examined. The collodio-chloride process was comparatively slow, and bichromated gelatine required two or three minutes' exposure to sunlight to produce a proper effect; but for the more sensitive developed negative processes a very much less powerful light or a reduced exposure was needed.

The performance of the copies was quite good, and, except where there was some obvious defect, I never could see that they were worse than the originals; in fact, in respect of brightness it not unfrequently happened that the copies were far superior to the originals, so that in many cases they would be more useful. I do not mean by that, however, that I would rather have a copy than an original if any one wanted to make me a present. There seems to be some falling off in copies; so that they cannot well be copied again, and if you want to work upon spectra of an extremely high order, dispersed to a great extent laterally from the direct line, a copy would not be satisfactory. The reproduction of gratings on bichromated gelatine is easily and quickly accomplished; there is only the coating of the glass over-night, rapid drying to avoid crystallisation in the film, exposure, washing, and drying. In order to get the best effect it is usually desirable to treat the bichromated copies with hot water. It is a little difficult to understand what precisely happens. All photographers know that the action of light upon bichromated gelatine is to produce a comparative insolubility of the gelatine. In the carbon process, and many others in which gelatine is used, the gelatine which remains soluble, not having been sufficiently exposed to light, is fairly washed away in the subsequent treatment with warm water; but for that effect it is generally necessary to get at the back of the gelatine film, because on its face there is usually a layer which is so insoluble as not to allow of the washing away of any of the gelatine to be found behind. But in the present case there is no question of transferring the film, which remains fixed to the glass, and therefore it is difficult to see how any gelatine could be dissolved out. However, under the action of water, the less exposed gelatine no doubt swells more than that which has received more exposure and has thus lost its affinity for water; and while the gelatine is wet it is reasonable that a rib-like structure should ensue, which is what would be required in order to make a grating, but when the gelatine dries, one would suppose that all would again become flat, and indeed that happens to a certain extent. The gratings lose a great deal of intensity in drying, but, if properly treated with warm water, the reduction does not go too far, and a considerable degree of intensity is left when the photograph is dry.

Although it belongs to another branch of the subject, a word may not be out of place as to the accuracy with which the gratings must be made. It seems a wonderful thing, at first sight, to rule 6000 lines to an inch at all, if you think of the smallest interval that you can readily see with the eye, perhaps one-hundredth of an inch, and remember that in these gratings there are sixty lines in a space of one-hundredth of an inch, and all disposed at rigorously equal intervals. Those familiar with optics will understand the importance of extreme accuracy if I give an illustration. Take the case of the two sodium lines in the spectrum, the D lines; they differ in wave-length by about a thousandth part; the dispersion—the extent to which the light is separated from the direct line—is in proportion to the wave-length of the light, and inversely as the interval between the consecutive lines on the grating; so that, if we had a grating

[1] An address delivered by Lord Rayleigh at the eighth annual conference of the Camera Club.

in which the first half was ruled at the rate of 1000 to the inch, and the second half at the rate of 1001 to the inch, the one half would evidently do the same thing for one soda line as the other half of the grating was doing for the other soda line, and the two lines would be mixed together and confused. In order, therefore, to do anything like good work, it is necessary, not only to have a very great number of lines, but to have them spaced with most extraordinary precision; and it is wonderful what success has been reached by the beautiful dividing machines of Rutherfurd and Rowland. I have seen Rowland's machine at Baltimore, and have heard him speak of the great precautions required to get good results. The whole operation of the machine is automatic; the ruling goes on continuously day and night, and it is necessary to pay the most careful regard to uniformity of temperature, for the slightest expansion or contraction due to change of temperature of the different parts of the machine would bring utter confusion into the grating and its resulting spectrum.

In printing, the contact has to be pretty close. and the finer the grating the closer must the contact be. I experimented upon that point by preparing a photographic film upon a slightly convex surface, and using that for the print; then, where the contact was closest, the original of course was very well impressed, and round that, one got different degrees of increasingly imperfect contact, and one could trace in the result what the effect of imperfect contact is. I found that, both with gratings of 3000 and 6000 lines to the inch, good enough contact was obtained with ordinary flat glass; but when you come to gratings of 17,000 or 20,000 lines to the inch the contact requires to be extremely close, and in order to get a good copy of a grating with 20,000 lines per inch it is necessary that there should nowhere be one ten-thousandth of an inch between the original and the printing surface—a degree of closeness not easily secured over the entire area. It is rather singular that though I published full accounts of this work a long time ago, and distributed a large number of copies, the process of reproducing gratings by photography did not become universally known, and was re-discovered in France, by Isarn, only two or three years since.

One reason why photographic reproduction is not practised to a very great extent is. that the modern gratings—such as Rowland's—are ruled almost universally upon speculum metal. A grating upon speculum metal is very excellent for use, but does not well lend itself to the process of photographic copying, although I have succeeded to a certain extent in copying a grating ruled upon speculum metal. For this purpose the light had to pass first through the photographic film, then be reflected from the speculum metal, and so pass back again through the film. Gratings such as could easily be made by copying from a glass original are not readily produced from one on speculum metal, and I think that is the reason why the process has not come into more regular use. Glass is much more trying than speculum metal to the diamond, and that accounts for the latter being generally preferred for gratings; indeed, the principal difficulty consists in getting a good diamond point, and maintaining it in a shape suitable for making the very fine cut which is required.

I may now allude to another method of photographic reproduction which I tried only last summer. It happened that I then went with Prof. Meldola over Waterlow's large photo-mechanical printing establishment, and I was very much interested, among many other very interesting things, in the use of the old bitumen process—the first photographic process known. It is used for the reproduction of cuts in black and white. A carefully cleansed zinc plate is coated with varnish of bitumen dissolved in benzole, and exposed to sunlight for about two hours under a negative, giving great contrast. Where the light penetrates the negative the bitumen becomes comparatively insoluble, and where it has been protected from the action of light it retains its original degree of solubility. When the exposed plate is treated with a solvent, turpentine or some solvent milder than benzole, the protected parts are dissolved away, leaving the bare metal; whereas the parts that have received the sunlight, being rendered insoluble, remain upon the metal and protect it in the subsequent etching process. I did not propose to etch metal, and, therefore, I simply used the bitumen varnish spread upon glass plates, and exposed the plates so prepared to sunshine for about two hours in contact with the grating. They are then developed, if one may use the phrase, with turpentine; and this is the part of the process which is the most difficult to manage. If you stop development early you get a grating which gives fair spectra, but it may be deficient in intensity and brightness; if you push development, the brightness increases up to a point at which the film disintegrates altogether. In this way one is tempted to pursue the process to the very last point, and, although one may succeed so far as to have a film which is quite intact so long as the turpentine is upon it, I have not succeeded in finding any method of getting rid of the turpentine without leading to the disintegration of the film. In the commercial application of the process the bitumen is treated somewhat brutally—the turpentine is rinsed off with a jet of water; I have tried that, and many of my results have been very good. I have also tried to sling off the turpentine by putting the plate into a kind of centrifugal machine; but by either plan the film in which the development has been too far pushed, is liable not to survive the treatment required for getting rid of the turpentine. If the solvent is allowed to remain we are in another difficulty, because then the developing action is continued and the result is lost. But if the process is properly managed, and development stopped at the right point, and if the film be of the right degree of thickness, you get an excellent copy. I have one here, 6000 lines to the inch, which I think is about the very best copy I have ever made. The method gives results somewhat superior to the best that can be got with gelatine; but I would not recommend it in preference to the latter, because it is very much more difficult to work unless some one can hit upon an improved manipulation.

I will not enlarge upon the importance of gratings; those acquainted with optics know how very important is the part played by diffraction gratings in optical research, and how the most delicate work upon spectra, requiring the highest degree of optical power, is made by means of gratings, ruled on speculum metal by Rowland. I suppose the reason why no professional photographer has taken up the production of photographic gratings, is the difficulty of getting the glass originals; they are very expensive, and I do not know where they are now to be obtained. It seems a pity that photographic copies should not be more generally available. I have given a great many away myself; but educational establishments are increasing all over the country, and for the purpose of instructing students it is desirable that reasonably good gratings should be placed in their hands, to make them familiar with the measurements by which the wave-length of light is determined.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. STANLEY DUNKERLEY has been appointed to the University Demonstratorship of Mechanism and Applied Mechanics at Cambridge, made vacant by the election of Mr. Dalby to the Professorship of Mechanical Engineering at Finsbury College.

AMONG the recipients of honorary degrees, conferred at the close of the summer session of the University of Edinburgh on Saturday, were Prof. Francis A. Walker. President of the Massachusetts Institute of Technology, and Sir Dietrich Brandis, K.C.I.E., F.R.S., late Inspector-General of Forests in India.

DR. J. D. PORTER, of Columbia College, New York, has been appointed to the newly-founded Macdonald chair of Mining and Metallurgy in the M'Gill University, Montreal. Mr. Herbert W. Umney, of Bath, has been appointed Assistant-Professor of Civil Engineering.

THE Council of the Hartley Institution, Southampton, have just made the following appointments:—Lecturer in Mathematics, Dr. Cuthbert E. Cullis, Assistant Lecturer to Prof. Karl Pearson, University College, London. Lecturer in Chemistry, Dr. D. R. Boyd, Demonstrator and Assistant Lecturer in Chemistry, Mason College, Birmingham. Lecturer in Biology and Geology, Mr. E. T. Mellor, Assistant Demonstrator in Biology, Owens College, Manchester.

HER MAJESTY'S Commissioners for the Exhibition of 1851 have made the following appointments to Science Research Scholarships, for the year 1896, on the recommendation of the authorities of the respective Universities and Colleges. The scholarships are of the value of £150 a year, and are ordinarily tenable for two years (subject to a satisfactory report at the end of the first year) in any University at home and abroad, or in some other institution approved of by the Commissioners. The

scholars are to devote themselves exclusively to study and research in some branch of science, the extension of which is important to the industries of the country. The nominating institutions and the scholars are as follows:—University of Glasgow, W. C. Henderson; University of Aberdeen, A. Ogg; Mason College, Birmingham, T. S. Price; University College, Bristol, E. C. Fortey; Yorkshire College, Leeds, H. M. Dawson; University College, Liverpool, H. E. Annett; University College, London, J. E. Petavel; Owens College, Manchester, J. L. Heinke; Durham College of Science, Newcastle-on-Tyne, J. A. Smythe; University College, Nottingham, G. B. Bryan; University College of Wales, Aberystwyth, S. W. Richardson; University College of North Wales, Bangor, D. Williams (conditional appointment); Queen's College, Galway, J. Henry; University of Toronto, A. M. Scott; Dalhousie University, Halifax, Nova Scotia, D. McIntosh; University of New Zealand, J. A. Erskine.

The following scholarships granted in 1895 have been continued for a second year on receipt of a satisfactory report of work done during the first year:—

Nominating institution.	Scholar.	Places of study.
University of Glasgow.	W. Stewart.	Universities of Glasgow and Berlin.
University of St. Andrews.	H. C. Williamson.	Marine Laboratories, Naples and Kiel.
University College, Dundee.	J. Henderson.	Polytechnicum, Munich.
University College, Liverpool.	J. T. Farmer.	MacDonald Engineering Laboratories, Montreal.
University College, London.	E. Aston.	University College, London, and University of Geneva.
Durham College of Science, Newcastle-upon-Tyne.	A. L. Mellanby.	MacDonald Engineering Laboratories, Montreal, and Durham College of Science.
University College, Nottingham.	M. E. Feilmann.	Polytechnicum, Zürich.
Queen's College, Belfast.	W. Hanna.	Laboratory of Royal College of Physicians and Surgeons, London, and Bacteriological Institute, Prague.
McGill University, Montreal.	R. O. King.	MacDonald Engineering Laboratories, Montreal. (To change for second year.)
Queen's University, Kingston, Canada.	T. L. Walker.	University of Leipzig.
University of Sydney.	J. A. Watt.	Royal College of Science, South Kensington.
University of New Zealand.	E. Rutherford.	Cavendish Laboratory, University of Cambridge.

A limited number of the scholarships are renewed for a third year when it appears that the renewal is likely to result directly in work of scientific importance. The following scholarships granted in 1894 have been renewed for a third year:—

Nomina g institution.	Scholar.	Places of study.
Universi of Edinburgh.	J. C. Beattie.	Universities of Vienna and Berlin.
University of Aberdeen.	W. B. Davidson	Universities of Würzburg and Leipzig.
University College, Liverpool.	Dr. A. J. Ewart	University of Leipzig and Botanical Institute, Java.
University of Toronto.	Dr. F. B. Kenrick.	University of Leipzig.

Generous gifts to educational institutions in America have often been noted in these columns. The New York *Critic* has collected some valuable information concerning the total amounts of such gifts and legacies received from various benefactors. Perhaps the following summary of these encouragements will create a spirit of emulation in the wealthy men of the British Isles before whom it may come. George Peabody, various, £1,035,000. Stephen Girard, Girard College, present value about £3,000,000. John D. Rockefeller, University of Chicago, £1,485,200; Vassar College, £20,000; Barnard College, £5000. Miss Helen Culver, University of Chicago, £205,000. Leland Stanford, Leland Stanford Junior University, from £3,000,000 to £4,000,000. Johns Hopkins, Johns Hopkins University, over £600,000. John C. Green, Princeton College and Lawrenceville School, £600,000. Anthony J. Drexel, Drexel Institute, £600,000. Asa Packer, Lehigh University, 115 acres of land and £500,000. Charles Pratt, Pratt Institute, £540,000; Charles M. Pratt, £8000. Leonard Case, Case School of Applied Science, £400,000. Henry W. Sage, Cornell University, £234,000. Cornelius Vanderbilt (deceased), Vanderbilt University, £200,000; William H. Vanderbilt, £92,000; Cornelius Vanderbilt, £8000. Peter Cooper and his family, Cooper Union, £330,189. Paul Tulane, Tulane University, £210,000. Seth Low, Columbia University, £200,000; Barnard College, £2000. Washington C. De Pauw, De Pauw University, £200,000. James Lick, University of California, £150,000. Isaac Rich, Boston University, £140,000. Ezra Cornell, Cornell University, £134,000. J. Pierpont Morgan, New York Trade School, £100,000. Colonel and Mrs. Richard T. Auchmuty, New York Trade School, £82,000. The total of this list, which is probably not complete, amounts to £15,080,389.

SCIENTIFIC SERIALS.

Symons's Monthly Meteorological Magazine, July.—The "International Cloud Atlas." Mr. Symons takes the opportunity offered by the publication of this work (of which only a very few copies have yet been distributed) to make a brief reference to the principal works on clouds which have recently preceded the present one, including M. Weilbach's "Nordeuropas Skyformer" (Copenhagen, 1881), the "Wolken-Atlas" of MM. Hildebrandsson, Köppen, and Neumayer (Hamburg, 1890), M. Singer's "Wolkentafeln" (Munich, 1892), "Classificazione delle nubi" by the Specola Vaticana, containing some excellent reproductions of M. Mannucci's photographs (Rome, 1893), and the Rev. W. Clement Ley's "Cloudland" (London, 1894). The "International Cloud Atlas" (Paris, 1896) has been prepared under the superintendence of the International Meteorological Committee, and contains twenty-eight coloured reproductions of clouds. Although none of them is from an English photograph, Mr. Symons thinks our countrymen may be well content to see how largely the international system of 1896 is based upon the work of Luke Howard, and that the classification adopted is practically that of the joint work of Dr. Hildebrandsson and the Hon. Ralph Abercromby.—The spring drought of 1896. Mr. Symons selected twenty-eight stations distributed over the United Kingdom; these show that the rainfall for the first half of the year at eight out of sixteen English and Welsh stations, the total fell below two-thirds of the average, the lowest values being 48 per cent. at Haverfordwest; while for the Scotch and Irish stations the average was 83 per cent. and 80 per cent. respectively. The results for April and May show that at three stations the rainfall was less than 20 per cent. of the average, the total in London being 19 per cent. In 1893 the drought was more severe in parts of England and Wales, but the 1896 drought in the south of Ireland appears to be unprecedented; at Cork it lasted for sixty-four days.

The numbers of the *Bulletino della Società Botanica Italiana* for May–July contain, in addition to papers of more local interest, one by Prof. G. Arcangeli on the elongation of the organs of aquatic plants (chiefly *Nymphæaceæ*), in which he expresses the opinion that the stress due to the weight of the superposed liquid is the chief stimulus for their adaptation to the depth of the water in which they live. The same author has a note on the sleep of plants, and the benefits which they derive from the varying positions of the leaves by night and by day.

The contents of the *Nuovo Giornale Botanico Italiano* for July comprise four papers, of which the titles only can be given:—The conclusion of Sig. L. Nicotra's exhaustive essay on the statistics of the Flora of Sicily; Sig. A. Lentiechia on morphological variations in wild and cultivated plants; Sig. F. Tasci on the mycology of the Province of Sienna; Sig. U. Martelli on a new species of *Centaurea* (*C. ferulacea*).

SOCIETIES AND ACADEMIES.

London.

Royal Society, June 18.—"The Determination of the Freezing-point of Mercurial Thermometers." By Dr. J. A. Harker.

The method adopted is to cool distilled water in a suitable vessel to a temperature below 0°, to insert the thermometer,

and then bring about the freezing of the water by dropping in a crystal of ice. The thermometer then rises, and finally attains a steady temperature, differing only very slightly from the true zero.

The apparatus employed consists of two portions, the thermostat and the cooler. The former is a copper vessel, filled with either refined petroleum or a strong solution of common salt. This vessel communicates with the cooler, through which the liquid can be pumped by a rotary stirrer; and by this means it can be cooled and maintained for some time at about −2°. The distilled water to be frozen is contained in a glass tube of about 300 c.c. capacity. This is first placed directly into the circulating liquid, and cooled quickly to −0·5° or −0·7°. It is then transferred to a cylinder lined with polished metal, placed in the centre of the thermostat. The thermometer whose zero is to be taken is then quickly fixed in position, the bulb and a considerable length of the stem above the zero being immersed in the water. A crystal of ice is dropped in, and the temperature quickly rises to the freezing point.

Experiments made with good mercurial thermometers showed that if ice be present in sufficient quantity, the final temperature attained by the mixture of ice and water is not influenced perceptibly by variation of the temperature of the circulating liquid within fairly wide limits. As, however, it seemed desirable to control this result by some other means, a platinum thermometer and bridge were designed, capable of indicating with certainty a change of 0·0001°, and a description of the whole arrangement employed to attain this degree of accuracy forms the second half of the paper. The resistances in the bridge were of manganin, and the thermometers were provided with the compensating leads, devised by Mr. Callendar. The maximum current which can be used in accurate measurements with these thermometers is about 0·02 ampere, and therefore the galvanometer employed required to be extremely sensitive. The instrument selected was a low resistance astatic one with vertical needle system, and gives at the greatest working sensibility one scale division for 1×10^{-10} ampere.

With this arrangement the influence of various conditions on the final temperature attained by the mixture of ice and water was studied. The results were found to be in close agreement with the theoretical deductions of Nernst, and it was quite easy to keep the temperature in the freezing vessel constant to within one or two ten-thousandths of a degree for an hour at a time.

The conclusion drawn from the previous experiments made with mercurial thermometers as to the small influence of changes in the external temperature, and in the temperature of the circulating liquid on that of the freezing vessel, was also confirmed, and it was found that a change of two or three degrees in the temperature of the circulating liquid only caused the temperature of the mixture in the tube to alter by three or four ten-thousandths.

EDINBURGH.

Royal Society, July 20.—The Hon. Lord M'Laren in the chair.—Prof. Tait gave a brief description of a paper by Lord Kelvin on the different configurations possible with the same law of force according to Boscovich. In previous papers the author had confined himself to a treatment of the nature of configuration. This paper was a daring application of principle towards a rational explanation of crystalline form, having regard to the mutual forces involved.—Prof. Ludwig Boltzmann's communication, read by Prof. Tait, on the importance of Clerk-Maxwell's contributions to the kinetic theory of gases, consisted of a few sentences setting forth the writer's high respect for Clerk-Maxwell, and defining his relations with M. Bertrand. The paper in full was promised later.—Dr. Halm read an abstract of his paper on theoretical researches on the daily change of the temperature of the air. The fundamental differential equations of the problem, so far as they concern the curve of temperature during night, were first propounded by A. Weilenmann, in his essay, "Ueber den taeglichen Gang der Temperatur zu Bern" (*Schweizerische Meteorol.*, Beobachtungen ix., 1872), which may be considered as the first successful attempt at investigating the question from a theoretical point of view. But the physical explanation of his mathematical terms being insufficient, the author undertakes to show that these equations are in perfect agreement with the fundamental laws of radiation and conduction of heat, as given by Fourier and many others. The general question, by what means does the lowest layer of the atmosphere, the temperature of which is recorded by our thermometric instruments, receive or lose heat, may be answered by this result. Every change of temperature is caused by continuous radiation between the soil and an unknown part of the atmosphere—for which, however, there can be substituted, under all circumstances, two masses of air with the same coefficient of radiation, one of these having the variable temperature of the observed lowest layer; the other, a constant temperature. The next part of the paper consisted in proving that Weilenmann's equations, by a proper application of the sun's radiating power at every moment during the day, can be used for deriving an integral which gives expression to the change of the temperature during the time from sunrise to sunset. This integral consists of two different parts, one of which contains two arbitrary constants, naturally involved by the process of integration; the others are functions of time introduced by the law of solar radiation on a horizontal surface. But it can easily be proved that both the arbitrary constants have to disappear in every case, so that the change of temperature appears to be regulated simply by functions directly depending on the radiating power of the sun. Considering the fact that the conditions of radiation must be importantly influenced by various systematical disturbances, such as convection currents, the continuous change of the quantity and quality of atmospheric moisture, the state of cloudiness and the physical conditions of the soil, great importance has to be laid on the question how these may be given expression to in the fundamental equations of the problem. As far as the convection currents are concerned, their influence is shown to be in perfect agreement with observations, the range of temperature being diminished, and the time of maximum being brought nearer to the culmination of the sun when the direction of the current is from a cold quarter; the opposite being the case when from a warm one. The effect of sea-breezes is an example of the former condition; that of currents flowing from a mountain to the valley during daytime, an example of the latter. The very considerable effect of the daily change in the amount of atmospheric moisture, which has been deduced from direct observation of clouds and the absolute humidity of the air, complicates the theoretical equation by adding a new term, the parameters of which can be shown to be in full agreement with these observations. The most important branch of the subject treated in the paper was the determination of the solar constant from the *daily* temperature observations, which, after the influence of the state of cloudiness and the change of the physical conditions of the soil therefrom resulting, have been investigated, show values sufficiently accurate to admit of examining the question of the periodicity of solar radiation by a method the advantages of which seem obvious compared with the commonly used method founded on study of mean *annual* temperatures. From a large number of stations in Austria and Hungary, whose observations, extending over the years 1876–93, have been used, the author shows a close correspondence between the inverted curve of sun-spots and that of solar radiation. A much fuller investigation, however, extending over a longer series of years, and embracing a greater extent of territory, is required to finally establish the results deduced.—Prof. J. M. Dixon, of St. Louis, described in an interesting and popular manner the tornado which recently visited that city, and of which he was an eye-witness. The report already given in NATURE (vol. liv. p. 104) he characterised as correct.—Mr. Robert Kidston read a paper describing some cones of *Sigillarii*, in which the structure of the sporangia was shown. The sporangia appeared to be immersed in the bracts in a somewhat similar manner to that which occurs in *Isoetes* showing that the affinities of *Sigillarii* are with *Isoetes*, as conjectured by Goldenberg. Two new species of Sigillarian cones (*Sigillariostrobus*) were described, and a new species of *Sigillaria*.—Prof. Charteris read a short paper on the physiological action of eucaine. He claimed for this new antiseptic, which he described merely as a compound synthetically prepared, that it was not so toxic as cocaine, while the anæsthesia it produced was as complete. It did not contract the pupil when applied to the eye, and a solution in water did not decompose.—The Chairman, in a few words, reviewed the work of the past session, and held out hopes of further prosperity and usefulness in the future.

PARIS

Academy of Sciences, July 27.—M. A. Cornu in the chair.—On the water-spout of July 26, at the Museum of Natural History, by M. Milne-Edwards. An account

of the disastrous effects upon the Museum produced by this water-spout.—On some new experiments relating to the preparation of the diamond, by M. H. Moissan.—Study of the black diamond, by the same. Black diamond, reduced to a very fine state of division, and heated in a stream of oxygen to a temperature about 200° C. below the temperature of combustion of the diamond, gives off a very small amount of carbon dioxide, and the diamond remaining is transparent.—A Spanish truffle and three new truffles from Marocco, by M. Ad. Chatin. The new specimens are described as *Terfezia Mellerionis*, of Laroche, *Terfezia Leonis* (var. *heterospora*), of Laroche, and *Terfezia Boudieri*, of Mazogan.—On the homogeneity of argon and helium, by Prof. W. Ramsay and J. Norman Collie. By fractional diffusion through porous tubes, argon yields two portions, of which the lighter has a density of 19·93, the heavier of 20·01. Similar experiments with helium gave densities of 1·874 and 2·133 for the two extreme portions, results which were confirmed by measurements of the refractive indices by Lord Rayleigh. Both specimens gave spectra which were absolutely identical, and hence the possibility is suggested of there being here a true separation of light molecules from heavy molecules of the same substance.—On the mononitrile of camphoric acid, its anhydride and anilide, by MM. A. Haller and Minguin.—On a method for giving the exact direction of a sound signal, by M. E. Hardy. Two methods are given for effecting this at sea.—Note accompanying two memoirs on thermochemistry, by M. Langlois.—On the error of refraction in geometric levelling, by M. Ch. Lallemand. It is shown that the effect of the refraction of the air, which can generally be neglected or eliminated in triangulation, becomes quite appreciable in levelling, and a formula is developed for introducing the necessary correction.—On the distribution of the displacements in metals subjected to stresses, by M. G. Charpy. The suggestion of M. Hartmann that metals, in spite of their known heterogeneous structure, behave as homogeneous bodies, has been submitted to further experiments, with the result that the displacements vary from point to point, and correspond in all respects with the structure shown micrographically.—On the density and mean specific heat between 0° and 100° of the alloys of iron and antimony, by M. J. Laborde. The numbers found for the specific heats are all greater than those calculated from the assumption of simple mixture.—On the determination of the ratio of the specific heats of gases, by MM. G. Maneuvrier and J. Fournier. The final results are: for air 1·392, for carbon dioxide 1·299, for hydrogen 1·384.—Researches on the relations existing between the radiation of a body and the nature of the surrounding medium, by M. Smoluchowski de Smolan. An experimental study of the formula of Clausius, according to which the emission should be proportional to the square of the refractive index of the medium. The general result is to confirm the law of Clausius.—Cranial endography by means of the Röntgen rays, by MM. Remy and Contremoulins.—Study of the nitrogren and argon of fire-damp, by M. Th. Schlœsing, jun. Specimens of fire-damp collected with suitable precautions from many sources all contained nitrogen, showing a notable amount of argon: the ratio of argon to nitrogen was, within the limits of experimental error, about the same as in air.—On the preparation of selenic acid, by M. R. Metzner. This acid is readily obtained by oxidising dilute solutions of selenious acid with free permanganic acid.—On a new cobaltite, by M. E. Dufau. By heating magnesia and cobalt sesquioxide in the electric furnace a crystallised magnesium cobaltite, $MgCoO_3$ is obtained.—On the solutions of trichloracetic acid, by M. Paul Rivals. A thermochemical study of the dissociation of trichloracetic acid in solution.—On vinyl-trimethylene and ethylidene-trimethylene, by M. G. Gustavson.—On the constitution of pinacoline, by M. Maurice Delacre.—Crystallographic properties of some alkyl-camphors of the aromatic series, by M. J. Minguin.—Formation and etherification of crotonylic alcohol, by M. E. Charon.—On the electrolysis of the fatty acids, by M. J. Hamonet.—On several modes of preparation of the blue nitrosodisulphonic acid and its salts, by M. Paul Sabatier.—New observations on *Clythra quadripunctata*, by M. A. Lécaillon.—Influence of the reaction of the medium upon the activity of the oxidising ferment of mushrooms, by M. E. Bourquelot.—On a cellulose filter, by M. Henri Pottevin. A description of a cellulose filter capable of taking the place of the biscuit porcelain filter. Owing to the cheapness of material, instead of the cleaning process necessary for porcelain, a new disc can be used.—The mechanism of the extension of the blastoderm, and its relation to the eye of the fish, by M. E. Bataillon.—On the presence in the superior laryngeal nerve of secretory and vasculomotor fibres for the mucous membrane of the larynx, by M. E. Hédon.—On the physiological significance of direct cellular division, by MM. E. G. Balbiani and F. Henneguy.—Study of the gizzard in some *Blattidæ* and *Gryllidæ*, by M. Bordas.—The constitution of the phosphates of lime from Tunis, by M. L. Cayeux.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—The Student's Handbook of British Mosses: H. N. Dixon and H. G. Jameson (Eastbourne, Sumfield).—The G. E. R. Co.'s Tourist Guide to the Continent (London).—A Text-Book of Physical Exercises: Dr A. H. Carter and S. Bott (Macmillan).—La Distillation des Bois: E. Barillot (Paris, Gauthier-Villars).—Monthly Current Charts of the Indian Ocean (London).—Catalogue of the Described Diptera from South Asia: F. van der Wulp (Nijhoff, Hague).

Pamphlets.—Peabody Institute 29th Annual Report (Baltimore). Symbolism in American Art: F. W. Putnam and C. C. Willoughby (Salem, U.S.A.).

Serials.—Astronomical Observations and Researches made at Dunsink, 7th Part (Dublin, Hodges).—Longman's Magazine, August (Longmans).—Chambers's Journal, August (Chambers).—Proceedings of the Aristotelian Society, Vol. 3, No. 2 (Williams).—Proceedings of the Edinburgh Mathematical Society, Vol. xiv. (Williams).—L'Anthropologie, tome vii. No. 3 (Paris, Masson).—Good Words, August (Isbister).—Sunday Magazine, August (Isbister).—Humanitarian, August (Hutchinson).—Contemporary Review, August (Isbister).—National Review, August (Arnold).—Physical Review, Vol. 4, No. 1. (Macmillan).—Bulletin de l'Académie Royale des Sciences de Belgique, 1896, No. 6 (Bruxelles).—Journal of the Institution of Electrical Engineers (Spon).—Journal of the Chemical Society, (Gurney).—Century, August (Macmillan)—Scribner's Magazine, August (Low).—Notes from the Leyden Museum, Vol. xviii. No. 1 (Leyden, Brill).—Fortnightly Review, August (Chapman and Hall)—Westminster Review, August (Warne).—Ornithologist, August (Bale).—Gazetta Chimica Italiana (Rome).—Revue Générale des Sciences, July (Paris).—Memoire della Spettroscopisti Italiani, July (Rome).—Bulletin de la Société d'Encouragement, July (Paris).

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THURSDAY, AUGUST 13, 1896.

TABLES FOR NAVIGATORS.

Azimuth Tables for the Higher Declinations (limits of declination 24° to 30°, both inclusive) between the parallels of latitude 0° and 60°, with Examples in the use of the Tables in English and French. By H. B. Goodwin, Naval Instructor, Royal Navy. Pp. xii + 74. London: Longmans, Green, and Co., 1896.)

A LEADING feature of present-day methods of navigation is the use of tables. There is scarcely any method in use in navigation for which one, and probably many, tables, of more or less practical utility, are not provided; and it would almost appear in some cases as though new methods had been proposed because tables could be prepared to use in connection with them, rather than because they were of real practical use. Some tables, such as those for "reduction to the meridian," may almost be regarded as luxuries, as they really save but little time and labour; though, on account of the easy adaptation of the formulæ to different forms of tabular computation, the number of them is large. On the other hand, there are tables which are really indispensable.

Of this latter class azimuth tables are a prominent type.

The object of the first of these azimuth tables, by Burdwood, published about a quarter of a century ago, was, to judge from the preface, merely to facilitate the calculation of compass error. Its publication, however, and that of its extension by Davis, may be said to have effected a revolution in the art of navigation, as Sumner's method, now so extensively used, was thereby rendered practically useful.

This method, of which the principle had been before recognised, was proposed by Captain Thomas Sumner, of Boston, in the year 1837. It enabled the navigator to determine *both* his latitude and longitude at *any* time, instead of being restricted to observations of the heavenly bodies, when near the prime vertical, for longitude; and when on or near the meridian, for latitude; observations for determining the latitude, in other cases, depending on a long process known as the "double altitude."

The principle of this method, as to which Lord Kelvin has remarked that every other method of navigation might be abolished so long as it was retained, is, that when the altitude of a heavenly body is observed, the observer must be situated somewhere on that small circle on the earth's surface which has the heavenly body as its pole. Another observation of the same body, when its azimuth has sufficiently changed, or of another body, at the same time, with an azimuth differing considerably from that of the first, places the observer, similarly, on another small circle. His actual position must therefore be at one of the two points of intersection of these circles; and. as these points are usually a long distance apart, his position, known approximately, will decide the question.

These circles, when transferred to a Mercator's chart, form regular curves, and the chords joining any two points on these curves within a few miles of each other, or the tangents to the curves through any points on them, such chords or tangents practically coinciding with the arcs, are called "lines of position." The intersection of two such "lines of position" fixes the position of the ship on the chart.

For the chord method the calculation of four longitudes would be necessary, *i.e.* two longitudes obtained from each of the altitudes with two assumed latitudes in the neighbourhood of the latitude by account; or else two longitudes and two latitudes when the heavenly body was near the meridian at the second observation. For the tangent method would be required two longitudes, or a longitude and a latitude, and two azimuths, as from the conditions of the problem, the tangent "line of position" must be at right angles to the heavenly body's azimuth.

Thus Sumner's method, though useful, was long and tedious, Captain Sumner himself remarking that the calculations would be much shortened and simplified if some ready means could be found of obtaining the azimuth of the body observed. This ready means is provided by Burdwood and Davis' tables. The longitude is calculated with the latitude by account; the azimuth taken from the tables, and the "position line" drawn through the position obtained. A second line is similarly drawn, the latitude being calculated, by reduction to the meridian, with the longitude by account, when the body observed is near the meridian, and the intersection of these two lines fixes the position of the ship.

Thus the cumbrous chord method is done away with, the tangent method is shortened and simplified. "Summer," therefore, almost deserves the character given to it by Lord Kelvin, especially as it is very usefu in high latitudes, in the winter months, during which the sun, when it does appear, is never very near the prime vertical, and the longitude obtained from observation of it is not so trustworthy.

Burdwood and Davis' azimuth tables give the true bearing or azimuth of any heavenly body whose declination lies between 0° and 23° north or south, for limits of latitude 0° to 60° north or south, for every four minutes of apparent time (in the case of the sun) or of hour angle (in the case of any other body). They are, therefore, most useful for obtaining the azimuth of any such body for compass error or line of position.

But the great increase in the speed of modern steamships necessitates more frequent observations in order to obtain the position of the ship. The correct position at noon each day was almost all that was required in the days of sailing ships and ships of low steam power. But now that ships may run 200 miles between noon and sunset on a summer's day, and considerably more between sunset and sunrise on a winter's night, it is necessary to know the position as often as possible, and strict orders are issued to the officer of the watch in Atlantic liners to omit *no* observation by which the ship's position may be determined.

Hence observations of the moon, the planets, and the stars are becoming of more frequent occurrence. One great advantage of observations of the moon is that it is frequently to be seen after sunrise or before sunset, and the position can be, therefore, readily fixed by simultaneous observations of the sun and moon (Sumner). Observations of the planets and stars can be made with *very* great accuracy in the twilight, and afford most satis-

factory results. There is, however, in the minds of many mariners an ill-defined idea that any problem not depending on the sun is too difficult to be meddled with. But so great a practical authority as Captain Lecky, in "Wrinkles on Navigation," says:

"For four or five months of the year navigation in our own latitudes is a much less ticklish affair when the stars are brought into action. In most cases they can be selected on or nearly on the prime vertical during twilight, and will therefore give a very reliable longitude."

The object of the present tables is to render Sumner's method applicable to the moon and planets in *all* cases, and to such bright stars as lie up to 30° of declination. The stars tabulated on page vii. of the preface are practically all available for longitude, and nearly all for latitude also.

The moon for about two-thirds of each month lies within the limits of "Burdwood and Davis," but for the remaining third it lies outside; and, as an example of a planet, Mars in 1896 has a higher northern declination than 23° from October 3 onwards.

When it is considered that the simultaneous observation of the sun and moon, already referred to, is admitted to be of great practical use even by those who are sceptical as to the general utility of observations of the moon, tables which permit Sumner's method to be applied to the moon at *all* times, at once establish their practical utility; and further, referring to the above-quoted opinion of Captain Lecky, it is to be remarked—

"That it is the very stars between 23° and 30° of declination (same name as latitude) which are particularly suitable for observation on the prime vertical, for the reason that in our latitudes such bodies have at the time a convenient altitude, whereas those of lower declination are too near the horizon when they have a bearing due east or west."

In this case again the practical value of the tables is obvious.

A somewhat interesting illustration of the value of observations of the stars is given in an article in the *Nautical Magazine* (June 1896). The article treats of the cross-currents said to be experienced in the Red Sea. Their existence was inferred from the discrepancy often noticed in the position of a ship as obtained from a.m. or p.m. observations of the sun. Recently, however, it has been considered that the discrepancy arises from the abnormal refraction experienced in the Red Sea, by means of which the position of the horizon is altered sufficiently to account for large errors in longitude.

In order to endeavour to settle the question numerous observations have been made, and the results tabulated. In a report on the subject by the Hydrographer of the United States, giving a detailed account of what has been done, the following paragraph occurs.

"The good agreement obtained between the results of the observation of dawn and twilight stars shows that excessive refraction is less frequent at those hours than at other hours of the day."

Tables, therefore, which tend to promote and simplify observations of the stars, when a ship is traversing a sea so full of dangers to navigation as the Red Sea has shown itself to be, should prove to be a boon.

In "Burdwood and Davis" the arguments are latitude, declination, and time. In the present tables "altitude" takes the place of "time" in the principal table. Table B is of use in the case of observations made when the altitude is greater than 55°, or is within 2° of the meridian altitude, the change in altitude being then so slow in comparison with the change of azimuth that it can no longer be regarded as a suitable argument. Table B is also of use in Sumner's method when an observation is made near the meridian, and the latitude calculated with an assumed longitude.

The use of altitude as an argument gives somewhat less minute results than the four-minute intervals, but there are great compensating advantages. The hour angle of the sun (or ship apparent time) is very readily found; but to find the hour angle of the moon, a planet, or a star, is a much more complicated matter. It involves a knowledge of ship time, right ascension of the sun, and right ascension of the body, presenting in addition a somewhat puzzling variety of cases. But the altitude of a star, &c., can be *accurately* observed in a few moments in the twilight when latitude or longitude is required, and can be observed with quite *sufficient* accuracy at any time, when visible, for the purpose of obtaining the azimuth or true bearing.

And this leads on to the second reason for the publication of these tables.

The process of observing the compass bearing of a bright star has been of late years very much facilitated by the introduction of Lord Kelvin's compass, so that the mariner has now the means of obtaining the error of his compass and of checking his deviation table at any time of the day or night when any of the heavenly bodies are visible. Here again we may quote Captain Lecky, who says: "It is perfectly wonderful how few men avail themselves of the stars on a fine night to see how their compasses are behaving." These tables, with the simple argument of a fairly correct altitude in place of a complicated hour angle, should render the practice of star observations for compass error as frequent as they are simple.

Such observation would appear to be most useful to the navigating officer of a ship of high speed, who may find that the variation has altered several degrees between sunset and sunrise. For example, in a ship steaming in the direction of New York, from latitude 45° N., longitude 60° W., it would be found that the variation had altered about 8° in a run of 300 miles, a distance that might very easily be traversed between such times as the sun was available for observation. It must therefore be of great assistance to the navigator that he should have a certain means of checking his compass error, not by the sun only, but by any heavenly body, of suitable and easily ascertained altitude, that may be visible.

Example iii. shows very clearly the value of the process (Examples i. and ii. showing the use of the tables as an aid to Sumner's method in the case of the stars and moon).

The methods for determining compass error show continual development. Formerly it was found by amplitude only, *i.e.* by the azimuth of the sun when its centre is on the horizon.

But, on account of refraction, the sun's centre appears to be about a diameter above the horizon when it is

really on it, and the correct position has to be guessed at. This never could be very satisfactory, and, in high latitudes with sun's declination of the same name, it is absolutely useless, as, owing to the small angle made by the path of the rising or setting sun with the horizon ($\cos^{-1}\{\sin \text{latitude} \cdot \sec \text{declination}\}$), the sun's azimuth may change several degrees while the altitude changes half a degree, so that it is practically impossible to estimate with any approximation to accuracy the correct amplitude; and when the sun's declination is greater than the co-latitude, the sun does not set at all.

Amplitude tables appear in all collections; but they might very well be dispensed with now that the compass error can be obtained with accuracy at any time of the day and night with the aid of "Burdwood and Davis," and the present extension to higher declinations.

In conclusion, a word of praise may be given to Messrs. Longmans for the clear and distinct manner in which the tables are printed. F. C. Stebbing.

CAVERNS AND THEIR INHABITANTS.

Les Cavernes et leurs Habitants. Par Julien Fraipont. Fcap. 8vo, pp. viii + 334. (Paris: Baillière et Fils, 1896.)

THE exploration of caverns during the twenty years which have passed since the publication of "Cave Hunting," has been carried on with an ever-increasing interest in various parts of the world. In France M. Martel has proved, by his adventurous descents into the abysses of these great laboratories of nature, that there is a charm in exploring them, similar to that which attracts the traveller to the highest summits of the mountains. If any one doubts this, let him read "Les Abîmes," where he will find a tale of descents into the principal European caverns that will remind him of the *Alpine Journal* turned upside down. In Central America the "Hill Caves of Yucatan" have allured Mr. Mercer to an expedition, the results of which have been recently published with admirable photographs. Here, as generally if not universally in the American caves, we look in vain for any traces of man older than the ancestors of the Indian tribes. In the book before us Prof. Fraipont, who had already made his mark as one of the discoverers of the human remains in the cave of Spy, deals with the general questions shortly and popularly, and with ample illustrations.

Our author treats, in the first place, the physical history of caverns, and divides them into those that have been formed by water and those which are of volcanic eruptive origin. In the first of these groups the caverns formed by the mechanical action of subterranean waters, combined with the chemical action of the carbonic acid in the water itself, are rightly separated from those formed by the erosive attack of the sea. The second group consists of those formed by the flow of liquid lava from a lava stream, after the upper parts and sides have cooled into the solid rocky condition. Caves of this sort are found in most volcanic areas, and notably in the island of Réunion and in Southern Italy. Prof. Fraipont classes with these the basaltic cave of Staffa, obviously the result of the attack of the waves on a line of weakness in the prismatic basalt. It is a sea cave pure and simple, and has no place in this group.

Prof. Fraipont, as might naturally be expected, passes by the present fauna of the caverns with a brief notice: the blind insects, the blind fish (*Amblyopsis*) of Kentucky and (*Lucifuga*) of Cuba, the blind *Proteus* of Carniola, and the large-eyed rat (*Neotoma*) of Kentucky that sees indistinctly. All these, so important from the light which they throw on the effect of the environment on their organisation, have no special interest in a work mainly given to the story of man in the Pleistocene caverns. To this we shall devote the rest of this review.

The Pleistocene caverns are treated from the usual standpoint of the French archæologist, and are divided into three groups, according to the alleged differences in the fauna and the occurrence of certain types of implements. (1) Those of the period of *Elephas antiquus* and *Rhinoceros merckii*, or the Chelles period; (2) those of the period of the mammoth and *Rhinoceros tichorrhinus*, or that of Moustier; and (3) those of the reindeer period. This classification is founded on the assumption that these mammalia and implements are characteristic of each division. Some animals preponderate in some caverns, and others in others, according to their habitat, and also according to the selection made by the hunters, who could kill, say, the reindeer more easily than the mammoth. As a matter of fact the study of the Pleistocene strata in France, as well as in Germany, Belgium and Britain, proves that all the above animals belong to one fauna in Pleistocene Europe. All have been found side by side in the gravel beds, for instance, on the banks of the Ouse at Bedford. The fact that the reindeer folk hunted the mammoth, as well as the rhinoceros, in France, is proved by the incised figures left behind as memorials of the chase. The differences in the implements, with the exception of the first, are probably local and due to tribal isolation, or to the scarcity or abundance of the materials for implement-making. The only two clearly-marked divisions, applicable to the whole of Europe, are (1) the Chelles period or that of the river-drift, and (2) that of the two latter of Mortillet (if Solutré be included, three) or that known to English archæology as that of the cave-men.

Human implements have been repeatedly met with in various caverns in France and Britain, and in the lower strata of Spy, in Belgium, which belong to the River-drift time; but with the exception of a solitary molar, found in one of the caves in the valley of the Elwy, no human remains have been discovered. It has been the good fortune of Profs. Fraipont and Lohest to find, in the cave of Spy, the first human skeletons, which belong beyond doubt to the cave-men, and are sufficiently perfect to allow of our arriving at a conclusion as to their physique. They are small with short arms and legs, and with a prognathous skull with low forehead, and enormous orbits overhung by strong superciliary ridges, with broad, strong cheek-bones, and with a long vault, similar to that of the skull of Neanderthal. They had small canines, and thigh-bones round in section, and without trace of platycnemism. Without accepting our author's view that they represent a "race humaine à caractères ethniques le plus inférieures que nous connaissons," we may conclude that they represent a family group of a

low type, which may be proved by future discovery to be a well-defined race, spread widely on the continent. We agree with him that the cave-men used fire-sticks, but we wait for further evidence before we can accept the conclusion that they were acquainted with the art of pottery-making. The cups, with round bottoms, found in the caves of Engis and Modave, are of the types met with in the lake-dwellings of Switzerland, such as Moringen and Concise, and are probably of Prehistoric and not of Pleistocene age. Nor can we accept his identification of the *Felis spelæa* with the tiger. It has been clearly shown in the Palæontographical Society's Memoirs, some twenty years ago, that it is a lion, differing from the tiger both in the shape of its skull and of its lower jaw. In treating of the range of this animal, our author has been unfortunate. In page 123 he tells us that "the great tiger of the caverns had disappeared in the Reindeer age," and, four pages later, that it was then alive. He speaks of it in one place as a tiger, in another as intermediate between a lion and a tiger, and in a third as an "extinct" type. His inclusion of the *Bos longifrons*, the goat, and the rabbit among the Pleistocene mammalia of France and Germany, is also open to doubt, the two first being probably introduced in the Neolithic age as domesticated animals, and the last having found its way northwards from Spain at a later time.

Although the Mammalia and, it may be added, the spelling of the names of places, people, and animals, are weak spots, the book may be summed up as an interesting addition to the literature of a complex and difficult subject, to which it forms a hand-book with valuable references. W. Boyd Dawkins.

THE PHOTOGRAPHY OF HISTOLOGICAL EVIDENCE.

Atlas of Nerve-cells. By M. Allen Starr, with the cooperation of Oliver S. Strong and Edward Leaming. Pp. x + 78. 53 plates. (Published for the Columbia University Press by Macmillan and Co., New York and London, 1896.)

"A CAREFUL drawing by a trained observer gives a better idea of appearances seen under the microscope than the best reproduction by photography can at present achieve." This statement was called forth by the consideration of a book similar in idea to the present, and apparently one of the same series, the "Atlas of Fertilisation and Karyokinesis of the Ovum," and was made a short time ago by Prof. Weldon in a notice of that book in Nature. It is forcibly recalled by the present book, the authors of which have been at the pains to present photographic representations of preparations showing nerve-cells, mostly prepared by the method of Golgi, any and all of which representations might with the greatest advantage, so far as clearness and facility of comprehension is concerned, have been replaced by a careful drawing of the cells which it was designed to illustrate.

The first idea that is evoked on looking at such plates as are here given, is that they are beautiful photographs of equally beautiful preparations. But the question *cui bono?* immediately forces itself upon one's mind. Are they intended to exhibit to other investigators the results of the author's investigations? This can hardly be the case, for it is not claimed that they show anything new, and every investigator can more or less readily make such preparations for himself. Are they intended for the student? This equally cannot be, since they are given in an expensive form, and are for the most part lacking in clearness; not from any fault in the preparations, but because the camera cannot be got to see more than one plane at a time. It is the hand which is constantly on the fine adjustment of the microscope that enables the shape of the body of a nerve-cell and the course of all its branches to be followed accurately, and it is only accidentally and imperfectly that these can be shown in a photograph.

The authors have themselves furnished the best possible illustration of the comparative value for teaching purposes of accurate drawings from good preparations, and of the best possible photographs from the same preparations, in giving (on p. 72, Fig. 10) a diagram of the cells of the cerebral cortex, "the cells being reproduced from the plates" (it would probably be more correct to say from the preparations). This diagram shows the cells with all their processes in relation to one another in the clear manner which we are accustomed to associate with representations of Golgi-preparations, and presents a marked contrast to the difficulty with which we make out some of the points which are stated to be shown in many of the photographs.

Moreover, as an account of the structure of the nervous system, which appears in some measure to be aimed at in this book, although not indicated in the title, the text which accompanies the plates is of no great value, since more complete and accurate accounts are within the reach of every student. It is indeed remarkable, considering that Dr. Allen Starr is the principal author, that quite serious errors, both of omission and of commission, should have found their way into the text. Thus, to take a single part of the nervous system, in a special enumeration of the connections of the cerebellum, the passage of the tract of Gowers into it by way of the superior peduncle—a fact indicated by Löwenthal and conclusively demonstrated by Mott—is ignored. On the other hand, the extensive descending degenerations described by Marchi, which have since been shown to have been produced in all probability by injuries to the bulb, accidentally made on removing the cerebellum, are still put forward as indicating an important centrifugal connection of the cerebellum with the spinal cord.

It may, further, be remarked that the present authors, like many others who have lately treated of the structure of the nervous system, have altogether failed to appreciate the importance of adopting for the nerve-cell a terminology which shall bring it into a line with all other cells in the body. Instead of speaking of the *body of the cell together with all its processes* as a "cell," they restrict the term cell to the body or nucleated part alone, and adopt the misleading term "neuron" to designate what is in fact the whole nerve-cell, ignoring the fact that νευρον literally means a sinew or fibre, and if applied

at all in this connection, should be restricted to the nerve-fibre process of the cell, for which they prefer the longer term *neuraxon!* Of course, as every one knows, our authors, in taking this course, are merely following the lead of a certain eminent German anatomist, it being a fashion with American scientific writers (except a few who prefer a sort of scientific Volapük) to follow pretty blindly all German scientific leads in the matter of nomenclature, and this even to the extent of bodily adopting actual German words into a language which can already find two or three synonyms for almost any word it may be desired to translate. No doubt many English authors are also to blame in this respect, but the fact is none the less to be deplored. And how can the average student be expected to understand the homologies of the nerve-cell if he is taught that he is not to call this particular unit a cell, like all the other units in the body, but is to restrict the term to a part of it only, for no other reason than the fact that when we were more steeped in ignorance of the structure of the nervous system than we are at present, that particular part of the nerve-cell was supposed to represent the whole!

Nevertheless, it may be freely admitted, in spite of the above criticisms, that many of the reproductions are extremely well done, and may with advantage be carefully studied by those who have not the opportunity of preparing for themselves specimens of like nature to those depicted. E. A. Schäfer.

OUR BOOK SHELF.

Flora der Ostfriesischen Inseln (einschliesslich der Insel Wangeroog). Von Prof. Dr. F. Buchenau. Dritte umgearbeitete Auflage. Small 8vo, pp. 205. (Leipzig: Wilhelm Engelmann, 1896.)

Dr. Buchenau is well-known as a botanical author for the simplicity and lucidity of his style, and the thoroughness with which he treats his subjects; and this little book is no exception to his usual work. Indeed, it is a model of what a local *Flora* should be, in striking contrast to the bulky barrenness of some of our English county *Floras*. It will easily go into the breast-pocket of a coat, and, as it contains descriptions and other information, it may be used, and be useful, in the field. The flora of the Frisian Islands is, on account of their situation, of great interest; and Dr. Buchenau has worked out its features, composition and peculiarities, with a full appreciation of its interest. An introductory chapter of some twenty-eight pages is a summary of the author's observations on various points; observations which have been published in full elsewhere, to which references are given. The paragraph on sand-binding plants is valuable. With regard to the flora as a whole, two principal points come under consideration, namely, its composition and origin. Taking into account the area, but more especially the slight elevation, the absence of trees, and almost so of shrubs, the flora is a comparatively rich one, and includes a number of species we should hardly expect to find. Dr. Buchenau says that the commonly accepted idea that the most interesting plants of the islands are relatively recent immigrants from the mainland of North-west Germany, will not bear investigation. "The most striking plants of the islands—*Liparis Lœselii*, *Gymnadenia conopsea*, *Epipactis latifolia*, *Parnassia palustris*, &c, are either wanting or exceedingly rare in East Friesland. They are only met with, by degrees, much further south. It is, therefore, inconceivable that they have migrated from the mainland in recent times, and assembled in these islands. The more probable explanation is that these plants are the remains of the old diluvial flora which from various causes have survived in the islands, though they have disappeared from the nearest mainland." I may add that Dr. Buchenau has made a special point of drawing up his descriptions, which are short and clear, from local forms. W. Botting Hemsley.

A Text-book of Physical Exercises adapted for the Use of Elementary Schools. By Dr. A. H. Carter and Samuel Bott. Pp. x + 168. (Macmillan and Co., Ltd., 1896.)

This book calls for notice in Nature because the exercises in it are founded upon a physiological basis. In a lucid introduction, Dr. Carter deals with "The Physiology of Exercise," and what he says should be read and digested by every teacher who has to do with the physical training of children. A knowledge of the structure and functions of muscular tissue is essential in order to fully appreciate the value of different exercises. For to know the physiological effects of exercise, the cause of fatigue, breathlessness, the nature of muscular stiffness, the reason why rest is necessary for the renewal of reserve force and the relief of muscular pains, is to possess the ability to judge the suitability of this or that exercise for the purpose of physical development.

Physical exercises have been carried out in the schools of the Birmingham School Board for the last ten years, and Mr. Bott, who organised and directs them, has, therefore, had ample opportunity of knowing the practical conditions of the exercises he describes. It is difficult to give clear and practicable instructions for the successful performance of such exercises as those with which the book deals, but, by means of concise text and numerous illustrations, this has been satisfactorily done. These instructions, and Dr. Carter's admirable lesson in physiology, will equip teachers with all they need know in order to carry out a sensible and systematic course of physical training for children.

Der Lichtsinn augenloser Tiere. By Dr. Wilibald A. Nagel. Pp. 120. (Jena: G. Fischer, 1896.)

Half of this interesting study is taken up by a paper on "Seeing without Eyes," in which the author considers the general question of sensitiveness to light, with illustrations from his own researches. In the second half these researches are described, and some special questions more fully discussed. The author's own observations were made chiefly on lamellibranchs and gasteropods, and showed a high degree of sensitiveness to light in the absence of anything like a visual organ. He found that some molluscs reacted especially to diminution, others to increase of light, and that this difference was correlated with other characters; those molluscs with soft shells, which bury themselves in the sand, reacted strongly to light, while those with hard shells responded more to shade. He found the highest degree of sensitiveness to light in Psammodia; and it is interesting to note, in relation to the common view as to the connection between sensitiveness to light and pigment, that the impregnated siphons of this mollusc were highly sensitive. Another interesting point investigated was the influence of repetition of a light stimulus. An oyster or mussel which has reacted to a shadow will react much less strongly, or not at all, to a second stimulus, even if much more intense, and does not recover its previous degree of excitability till more than an hour has elapsed. The book concludes with a full bibliography.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Utility of Specific Characters.

PROF. LANKESTER (p. 245) has alluded to the dark pigment in the skin of tropical man as "conceivably . . . not in itself a useful, that is, a life-preserving or progeny-ensuring character, but merely the *accompaniment* of a power of resisting malarial germs . . ." residing in the leucocytes. This hypothetical case, used by Prof. Lankester for illustrating his argument, has been seriously entered upon by Mr. Thiselton-Dyer (p. 293), with the conclusion that "it does not follow that epidermal pigment is useless because one explanation of it seems to fail."

I beg permission to call attention to a paper in NATURE, vol. xxx. p. 401, by Surgeon-Major N. Alcock, "Why tropical man is black," which paper has seemed to me of great importance from the time I read it. Ingenuous considerations, together with quotations from various authorities, led Mr. Alcock to the opinion, that the dark pigment of tropical man's skin does serve as a protection against the rays of *light*. Whereas ". . . pigment placed behind a transparent nerve will exalt its vibrations to the highest pitch"—viz. in the eye—". . . the pigment in front of the endangered nerve reduces its vibrations by so much as the interrupted light would have excited, a quantity which . . . would, when multiplied by the whole area of body-surface, represent a total of nervous action that if continued would soon exhaust the individual and degrade the species."

In this way, the blackness of the negro which, as regards *heat* alone, must appear far from protective, will act as a screen against "the twin stimulant of life," light. "May it not, therefore, be claimed that there is much foundation for the suggestion that the black skin of the negro is but the smoked glass through which alone his wide-spread sentient nerve-endings could be enabled to regard the sun?"

There is no lack of evidence in support of this view. I will confine myself to mentioning a letter by Mr. Flinders Petrie (NATURE, vol. xxxiv. p. 76).

Perhaps I may remind the leaders in the old strife about the utility of specific characters, of the remarkable statements in "Descent of Man" (second edition, p. 61), commenting on the important concessions which, in the fifth edition of the "Origin of Species," Darwin has made to the views of Nägeli and others, concerning ". . . the existence of structures, which, as far as we can at present judge, are neither beneficial nor injurious . . ." DAVID WETTERHAN.

Freiburg, Badenia, August 1.

The Position of Science at Oxford.

IN the correspondence which your recent interesting article on this subject has evoked, the writers have mainly applied their criticism to particular aspects of the general argument raised. This is natural, for they have, scarcely without exception, been professionally interested in the teaching and progress of science, and their letters seem to show that an impression exists that there is a cause for blame in the matter, but that there is an uncertainty at whose door this blame should be laid. May I briefly examine the complaints which your original anonymous correspondent brought against the University authorities, and the present system in vogue at Oxford.

The first complaint has reference to the allotment of college scholarships to science. The argument may be admitted that strict justice demands that fifty-five scientific scholarships should be given; that only forty-four science scholars were last year in residence is incorrect. There were at least half-a-dozen men, receiving the emoluments of a nominally mathematical scholarship, who were preparing to take physics as a second school. Then, again, Christ Church annually gives an exhibition of the value of £85. If this be reckoned as equivalent to a scholarship, as in common fairness it should be reckoned, it is perfectly evident that it is not desirable to offer more scholarships in natural science until the school becomes larger, or the competition more severe than is at present the case. It is not unimportant to point out that an examination of the Natural Science Class Lists would show that some of the holders of these emoluments have not justified their selection.

The second part of the indictment against the college authorities is concerned with the appointment (or non-appointment) of science tutors. And in this matter your article is calculated to give a wrong impression, for it should be clearly understood that the college can exercise no compulsory power in choosing a course of study for any commoner. That commoner only can be influenced in this way, who starts his university career with no preference for a particular school, and it is inconceivable that such an one can ever really adorn any branch of study. But the man who knows what he wants to do, will find that he can get all the assistance he requires from his college lecturer, and that he is in no way worse off because the latter is not on the tutorial staff.

Your article contains a comparison between the conditions which obtain at Oxford and Cambridge respectively, much to the disadvantage of the former, and three reasons are given for the fact. First, at Cambridge scholarships are given to men of one year's standing; but if a man has failed to win a scholarship before his second term, it is not easy to see how he will qualify for one after a year's work. The fact that there is no lack of candidates of sufficient merit at Cambridge, is beyond a doubt largely accounted for by the fact that the scholarships are in many cases of smaller monetary value, and a lower standard is consequently expected. Secondly, a greater prestige attaches to the science school at Cambridge; and this is probably the greatest hindrance to an increase in the science school at Oxford. Time alone, by removing this ignorance and prejudice, can overcome the popular idea that science teaching is better, and, it might be added, cheaper in one university than in the other. At any rate, it cannot be said that Oxford collectively has not done her best to remove any inferiority she may have had in the past. The third argument is that the ranks of Oxford undergraduates are mainly recruited from the public schools, that science teaching in public schools is bad, and that the university is responsible. In fact, the essential argument of the article, and the only one that can possibly stand the test of criticism, is that the examination known as "responsions" urgently needs alteration, both in the direction of excluding the compulsory Greek test, and including an examination in the elements of natural science. Such an alteration, it is contended, would improve the science teaching, and it is the duty of the university to effect this reform.

The question of the Greek test is not new, and it cannot be denied that it has been considered and discussed with the utmost deliberation by those who have decided in favour of its retention. It is idle, in the face of facts, to throw a doubt on the sincerity of the University's good will towards science: it is equally impossible to deny, and it is admitted in your article, that the university is perfectly right to demand of its alumni a preliminary "fair general education"; at the same time, it would be difficult to name a body better qualified to decide what is a good general education than Convocation itself. The writer of your article appears to think that the dons—especially the younger dons—are foolish, childish, narrow-minded persons, absolutely ignorant of science and modern languages. This is, fortunately, far from true, and their deliberately expressed opinion, on a point of the greatest importance in public education, is assuredly entitled to some respect. Your correspondent complains that the knowledge of Greek demanded is too small to serve any useful purpose, and some of us may wish that the standard should be raised; but this complaint applies far more aptly to Cambridge than to Oxford. After all, a knowledge of Greek is insisted on because it is the most beautiful, the most expressive language ever written, and it contains the finest literature. A boy may forget how to conjugate a Greek verb (the sneer is rather hackneyed), but the reading of a Greek play, perhaps the most perfect form of literature the artist could use, will still have left a permanent effect on the mind of any one who is capable of culture. Besides, since a proper equivalent for Greek, even if a substitute be possible, will require as much time and as much application in its preparation, it is difficult to see in what way this alternative subject—be it German or any other—will prove more suitable, more convenient, or more congenial.

The question remains of making a knowledge of the elements of natural science compulsory in responsions, for compulsory it must be, if it is to change the existing state of things. The occasion for making this proposal is certainly unfortunate, for it evidently appears to be made not so much as an abstract suggestion for the improvement of education in general, as a scheme for the express purpose of improving the scientific teaching in schools. That it would have even this latter effect is open to

doubt, for mathematical teaching is almost as bad as scientific, although mathematics is compulsory in responsions. But it is clear enough that the proposal can only be defended on the former ground, for it would be preposterous to impose a useless burden on ninety-five per cent. of undergraduates, in order to raise the standard of a particular five per cent. Now, independently of the fact that the "elements of natural science" is a phrase very vague and difficult to define, it may be fairly urged that these "elements" consist of a series of interesting and important facts, of which, however, the connection and interaction is by no means apparent without a fairly comprehensive knowledge. It would be perfectly useless to have a knowledge of natural laws, when the idea of "law" is, in itself, entirely imperfect, as Helmholtz has held it to be in the unmathematical mind. A knowledge of science may be desirable, but equally so is a knowledge of history, or of English law. But if it be expedient to enlarge the scope of responsions in any way, it is abundantly clear that deeper, instead of wider, knowledge should be required: for example, the standard of mathematics might with good reason, perhaps, be raised.

One more remark seems needed in reply to your article. In attributing to the Greeks a true scientific spirit, your correspondent shows a strange and radical misconception of the tendency of Greek philosophic thought. The Hellenic spirit always inclined to speculative and metaphysical, as opposed to experimental philosophy, and Aristotle probably did more to retard our knowledge of natural science than any ten men have ever done to advance it.

The science school at Oxford may, and it is to be hoped will gradually improve, both in size and in quality; especially is there room for hope in the case of the medical school, though it is sadly handicapped by the absence of those opportunities for practical teaching which only a great hospital, situated in a crowded city, can afford. But it is useless to hope that the whole natural science school will ever become very large, so long as the tendency towards devolution and decentralisation in university (which ought to mean the highest) education continues. The principle of centralisation of educational forces, the enormous importance of which seems nowadays to be so lamentably lost sight of, possesses an especial validity in the case of scientific education. If this principle be neglected, it is our own fault if we find, on the one hand, a teaching staff of the highest order without pupils to instruct, and admirably equipped museums and laboratories standing practically idle and in abeyance; and, on the other hand, the best teachers so scattered up and down the country as to hinder the receptive student from gaining the advantages he would otherwise reap from their combined and systematised tuition. W. E. P.

Liverpool, August 3.

The Mandrake.

IN an anonymous work in Chinese, "Tiau-sieh-lui-pien" (1), nine plants are named as frequently to assume the human or animal figures, viz. cypress, Nan-tree,[1] turnip, mustard, citron, *Pachyma cocos*, *Lycium chinense*, *Phytolacca acinosa*, and *Panax Ginseng*.[2]

Of these nine, doubtless the Ginseng is the plant most celebrated for its medicinal virtues imaginarily connected with its anthropomorphous root (2); but as far as the multiplicity is in question of the legends talked of analogous to the mandrake-stories, certainly the Shang-luh (*Phytolacca acinosa*) is the most notorious one.

Under the heading at the beginning of this letter, I wrote to NATURE (vol. li. p. 608, April 25, 1895) a note on the analogies between the mandrake- and the Shang-luh-lores, pointing out the two instances, viz.:

(1) The roots of the two plants are said to have human shape.

(2) Both plants are said to have the power of shrieking.

Continuing in the research from that point, I have found further the additional points of analogy, that are as follows:—

[1] Some Japanese botanists (*e.g.* Matsumura, "Nippon Shokubutsu Meii," Tôkyô, 1884. p. 64) identify the Chinese "Nan" with the Euphorbiaceous plant, *Daphniphyllum macropodinum*; whether the identity is a sound one, I do not know.

[2] Most plants here enlisted, seem to have the alleged figures in their subterraneous members; only the citron might produce the fruits of such a configuration. As to the named trees, the cypress of Kien-ling was anciently valued for its wood, the veins of which represented naturally angels, clouds, men and animals ("Yuen-kien-lui-han," *op. cit.*, tom. ccccxiii. art. "Peh," 1); whereas the alleged human figure of the "Nan" was apparently formed by its stem and branches (*cf.* H. Ransdell, "Through Siberia," 1882, vol. i. p. 158).

(3) The Shang-luh is said to grow upon the ground beneath which dead man lies; and the mandrake is recorded to thrive under the gallows (3).

(4) When the Shang-luh is about to acquire the power of speech, *ignes fatui*, it is said, crowd about it (4). About the mandrake Richard Folkard remarks: "In an Anglo-Saxon manuscript of the tenth or eleventh century the mandrake is said to shine in the night like a candle. The Arabs call it the Devil's Candle because of this nocturnal shining appearance. . . ." (5)

(5) Chang Urh-Ki, a Chinese literatus of the seventeenth century, writes: "A sorcerer carves the root of Shang-luh into a human effigy, which he makes through his spells capable of telling the fortunes" (6). This forcibly brings to mind the old European belief in the diminutive prophetic images made out of mandrake-root[1] (7).

(6) The mandrake had a reputation that it makes men insane and the reason prisoner (8); correspondingly the red variety of Shang-luh[2] is described by Su Kung (*c.* 656) to be so poisonous as to cause men to see the demons (*i.e.* to make men delirious) (9).

(7) In "Pan-tsau-king," the oldest Chinese authority on materia medica, attributed to the mythical emperor, Shin-Nung, the Shang-luh is mentioned to kill the demoniacal beings; and, later, Teau Hung-King (452–536) speaks of its influence on the "Malignant Worms," which it drives out of the possessed (10), this efficiency being no doubt the principal reason for the Tauist usage of the white Phytolacca under the pseudonym of "Luh-fu" (or "Dried Venison") (11). Still later it is reputed by Ta-Ming (*c.* 968) to purge the "Poison of the *Ku*"[3] (12). Quite conformable to these is the ancient Jewish belief in the exorcising power the herb Baaras (or the mandrake) was renowned to possess (13).

(8) A recipe quoted by Chang Urh-ki from a "Book of Divine Physic" (14) seems to imply the old Chinese usage of the Shang-luh as philtre as much as the mandrake was highly esteemed therefor (15).

(9) "From the remotest antiquity the mandrake was reputed in the East to possess the property of removing sterility; hence Rachel's desire to obtain the plant that Reuben had found. . . ." (16). Now we read in a Chinese herbal that the black, ripe fruit of the Shang-luh is highly valued by rustic women, for it favours their fertility (17).

(10) Of the medicinal properties these plants are known to possess, some are common to both. Matthioli, referring to Galen, speaks as a cooling stuff of the mandrake (18), Li Shi-Chin assigning the same character to the Shang-luh (19). Both herbs were famed for their purgative functions, and both were applied to indolent and scrofulous tumours, and to swellings of the glands (20).

[1] From their traditions, the Chinese appear to have had about the Fung (*Liquidamber Maximowiczii*) two points of analogy to the mandrake-lore. First, Jin Fang's "Shuh-i-ki" (written sixth century, A.D., ed. Wang, tom. ii. fol. 10, *b*) contains the following passage: "In Nan-Chung there is the 'Liquidamber-Elf' (Fung-sze-kwei), which is the old tree of the named species transformed to man in its shape. Second, other authorities say a tumour develops upon the old Liquidamber; after a thunderstorm it elongates to three or five feet in length. Now the sorcerer carves this tumour to a human effigy to play black art thereby in a similar manner to the practice with the Shang-luh. However, in case a proper formula is not observed while gathering it, the tumour flies away and never serves the purpose (*cf.* Ki Ngan, "Nan-fang-tsau-muh-chwang," fourth century, A.D., Brit. Mus. copy, 15255, *a.* 5, tom. ii. fol. 1, *a*; Wu Ki-Siun, *op. cit.*, tom. xxxv. fol. 2 *a*; Sie Tsai-Kang, *op. cit.*, tom. x. fol. 4). Whether related to the latter belief or not, I remember some old men in Japan ever extolling the merits of images of Daikoku, the god of riches, artificially formed out of tumours on *Gingko biloba*.

[2] That is, the variety with its calyx coloured pale rufous. Kan-Pau-Shing, a herbalist of the tenth century, observes of the Shang-luh: "The red flower accompanies the red root and the white flower the white root" (*See* Iinuma, "Sômoku Dzusetsu," new ed., 1874, vol. vii. fol. 89, *b*; Li Shi-Chin, *loc. cit.*)

[3] "The district of Kiang-Nan is much infested by the *Ku*. On the fifth day of the fifth moon, the future keeper of the *Ku* puts together in a vessel a hundred different sorts of animals, varying in size from serpent to louse, which are left therein to mutually devour till but one remains the strongest. This he keeps and feeds in his house as the *Ku*. Whomsoever the keeper wishes to destroy the *Ku* infests in the viscera; consequently the man dies, his treasures passing over to the *Ku*-keeper's house," &c. ("Sui-shu," written seventh century, A.D., quoted in Tsiau Hwang, "Tsiau-shi-pih-shing," Brit. Mus. copy, 15316, *a*, fasc. ii. tom. v. fol. 24, *a*; Ching Tsiau, *op. cit.*, tom. xxxiii. fol. 11, *b*; *cf.* Morrison, "Dictionary of the Chinese Language," London and Macao, 1823. vol. iii. part i. p. 288.) Among the stories pertaining to the *Ku* several incidents occur parallel to those about the mandrake (*cf.* Folkard, *loc. cit.*; Li Shi-Chin, sub. "Kin-tsan"; Kitamura, Kiyû Shôran, new ed., Tôkyô, 1882, tom. viii. fol. 22). Just as are the cases with the mandrake and the Shang-luh, a herb called Lang-tang (*Scopolia* sp.?) is reputed to make men insane, yet withal to cure demoniacal possession (*cf.* Wu Ki-Siun, *op. cit.*, tom. xxiv. fol. 77, *b*; Josephus, *loc. cit.*).

So far the many analogies between the mandrake- and the Phytolacca-stories appear to militate against the probability of the independent growths, if not origins, of the folk-lores connected with the two plants.

Further, it may be worthy of notice that, while the ancient Europeans possessed a hazy knowledge of the anthropomorphous Ginseng (21), the Chinese of middle ages had an equally circuitous acquaintance with the mandrake. The fact is well evinced in the following passage of Chau Mih (1232 1308) (22): "Several thousand miles west of the Region of Moslem,[1] the land produces one substance extremely poisonous, which is shaped like man as our Ginseng is. It is called 'Yah-puh-lü,' and grows under the ground several *chang* deep [1 *chang* = 10 Chinese feet]. Should a man bruise its skin, its poison would adhere to and kill him. The only method of gathering it is this: dig around the said substance a hollow deep enough for a man's management therein; with one end of a thong tie up the substance lightly, and with other end bind round a big dog's leg. Now flog the dog; he will, striving to avoid the danger, pluck the substance from the ground, but he will die instantly. The stuff thus procured is buried under other ground, whence it is taken out a year after; then it is dried and prepared with another medicine. When man takes internally a bit of this mixed with wine, it makes him soon fall down unconscious even of cuts and chops; still there is a certain drug which, if used within three days, can recover the man. It is very likely that the celebrated Hwa To [a surgeon who flourished in the third century, A.D.] barely resorted to this drug when, as is traditionally said, he cut open his patients' bellies to cleanse viscela without harm. Presently we learn our Imperial Hospital possesses two pieces of this drug."

The readers of the above passage scarcely need my annotations that the story is obviously composed of what Josephus and Dioscorides record (23), and also that the name "Yah-puh-lü" is nothing but "Ybruh," the Arabic word for the mandrake[2] (24).

References.—(1) In "Hai-shan-sien-kwan-tsung-shu," tom. xlvi. (published 1847), pt. i., fol. 76, *b*; the Imperial Cyclopædia, "Yuen-kien-lui-han," 1701, *passim*. (2) "Encyclopædia Britannica," 9th ed., vol. x p. 605. (3) *Cf.* Folkard, "Plant Lore, Legends, and Lyrics," 1884, p. 427; also my letter in NATURE, *op. cit.* (4) Sie Tsai-Kang, "Wu-tsah-tsu," *c.* 1610, Jap. ed., tom. x., fol. 41, *b*, quoted in my letter, *ubi supra*. (5) Folkard, *l. c.* (6) "Hau-ngan-hien-hwa," Brit. Mus. copy, 15316, *a*, tom. i., fol. 4, *b*. (7) Same as (5) and (8). (8) "Encyc. Brit.", vol. xv. p. 476. (9) and (10) Li Shi-Chin, "Pan-tsau-kang-muh," art. "Shang-luh." (11) Ching Tsiau, "Tung-chi," Brit. Mus. copy, 15281, *a*—*d*, tom. lxv., fol. 28, *a*. (12) Same as (9). (13) Josephus, "Jewish War," trans. Traill, 1851, book vii. p. 230. (14) Same as (6). (15) and (16) Folkard, *op. cit.* (17) Wu Ki-Siun, "Shih-woh-ming-shih-tu-kau," completed *c.* 1848, ed. Ono, Tokyô, 1884, tom. xxiv., fol. 16. (18) "I Discorsi, &c.," Venetia, 1568, p. 1136. (19) Same as (9). (20) *Cf.* W. Rhind, "History of the Vegetable Kingdom," 1874, p. 552; same as (8) and (9). (21) *e.g.* Cruden, "A Complete Concordance to the Old and New Testament," 20th ed., p. 436. (22) "Chi-ya-tung-tsah-chau," Brit. Mus. copy, 15316, *a*, tom. i. fol. 41-42. (23) Josephus, *l. c.*; Mart Mathée, "Les six Livres de Pedacion Dioscoride," Lyon, 1559, l. iv., ch. lxv. p. 274. (24) Pickering, "Chronological History of Plants," Boston, 1879, p. 247.

KUMAGUSU MINAKATA.

15 Blithfield Street, Kensington, W., July 16.

P.S.—In writing the present letter, I have not consulted the late Prof. Veth's exhaustive account of the mandrake-stories referred to in NATURE (vol. li. p. 573.) To my great regret it is written in Dutch, a language which is beyond the reach of my understanding. K. M.

[1] In another work by same author, "Kwei-sin-tsah-shih," quoted by Li Shi-Chin, *op. cit.*, sub. "Yah-puh-lü," this herb is said to grow in the "Region of Moslem, north of the Desert," and there it is indicated that the degraded officers of an extreme ignominy used this drug [to feign self-murder]. The Imperial "Yuen-kien-lui-han," *op. cit.*, tom. ccccxi., gives a proverb: "Eat the herb by name Yah-puh-lü; you die, still you are not dead."

[2] Fang I-Chi, the most erudite Chinese of Christian faith, referring to a work of the thirteenth (?) century, "Fang-yu-shing-loh," gives the habitat of the narcotic "Yah-puh-lü-yoh" in the country of Medina ("Tung-ya," 1643, tom. xli., fol. 8, *b*). Conventionally the latter name might be interpreted as the "Drug named Yah-puh-lü," but I am rather inclined to trace it to the name "Yabrochak" used in Palestine for the mandrake (Pickering, *loc. cit.*)

THE ECLIPSE OF THE SUN.

IF it be true that science advances through failures, the clouds which prevented the observation of the total eclipse of the sun last Sunday may be a blessing in disguise. During the past quarter of a century, several astronomers have taken up the problem of discovering a means of photographing the corona in broad daylight, but the results have not been very encouraging. In the photography of solar prominences, Prof. Hale and Dr. Deslandres have obtained distinctly valuable pictures, and, were it possible to delineate the corona with the same success on any day when the sun is shining, our knowledge of the nature of that solar appendage would increase much more rapidly than it can at present, when the only opportunities for studying it are afforded by the brief moments of totality of a solar eclipse. Perhaps last Sunday's experience will induce solar physicists to give further attention to the artificial reproduction of eclipse conditions. It is, of course, not suggested that every-day observations will make eclipse expeditions unnecessary—there will be work for astronomers during solar eclipses for a long time to come—but if it were possible to carry out systematic researches on the structure and constitution of the solar surroundings, instead of depending entirely upon the rare intervals when the photosphere is obscured, several moot points might be settled before the end of this century.

Observations of the total eclipse of Sunday last were made impossible by clouds. From all along the line of observers, the same report of foiled intentions has been received. At Vadsö, and in the neighbourhood, the sun was entirely obscured during totality, and no observations of scientific importance were obtained. The party of Russian astronomers who stationed themselves at the village of Orloffskoe, on the Amur, were equally unsuccessful in making observations. The eclipse was visible as a partial eclipse at Tokio, but at Akeshi, in the island of Yezo, where the Japanese, American, and British observers had set up their instruments, the weather was wet and the sky cloudy, and it is reported that the preparations made ended in a fiasco. It is not definitely known what happened at Esashi, where Prof. Todd and Dr. Deslandres were stationed, but little hope of success is entertained. A telegram received at Copenhagen from Bodö, Norway, states that a photographer from Flensburg has taken eleven photographs of the eclipse at Bredvik, on the Skjerstad Fiord, but more details are needed before an opinion can be expressed as to their value. News has yet to be received from the British observing party at Nova Zembla, and from the expeditions of the Russian Astronomical Society stationed at Enontekis (Finland), the mouth of the Obi, and Olekminsk, on the Lena.

Mr. Norman Lockyer has sent us the following telegram from Kiö Island, where he established a station to observe the eclipse: "Although the sun was clouded during totality, the sight was most impressive. The darkness was so great that lamps were needed. The party from H.M.S. *Volage* consisted of seventy-seven observers all trained to make notes or drawings of particular characteristics of eclipse phenomena, such as coronal structure, extent of the corona, and the colours of sky, cloud, and land and water surfaces, and to take the times of contact. The party was also provided with spectroscopes for analysing the lights of the corona and prominences, prismatic cameras for photographing the spectra of these objects, and polariscopes." With such an army of organised observers, an immense amount of valuable information would have been accumulated had the eclipse been visible. The exceptional opportunities for accurate observation offered by the presence of the Training Squadron gives astronomers reason for keen disappointment at the failure of the eclipse as an observable event; but students of science are used to the

destruction of their hopes, and the next total solar eclipse will be as eagerly looked forward to as the one just hidden from them.

An interesting description of the scene in the neighbourhood of Vadsö appeared in Tuesday's *Times*, and the following is an abridgement of it.

On Sunday morning the Varanger Fiord in the north-east of Norway presented a scene which has probably never before been equalled in a latitude of 70°. The anchorage at the port of Vadsö was crowded with men-of-war, yachts, and passenger steamers, brought together by reason of the total solar eclipse. For several days the numerous astronomers on these ships have been engaged in landing their delicate and elaborate instruments, and transporting them to the beautiful sites which here abound.

By last night the laborious preparations of the different observing parties had been completed, and they awaited with what composure they might the momentous events of the morrow. In any circumstances an Arctic summer night, where broad daylight reigns throughout, is very different from a night in a temperate region. But on this occasion there were so many interruptions, partly by the arrival of friends in the various ships, that rest was but little thought of, and indeed from two to five and even earlier a succession of boats brought hundreds of passengers from the ships to the shore.

The fence which marked out the ground occupied by the observers was guarded by bluejackets, charged with the duty of keeping at a suitable distance the groups of picturesquely-clad Finns and Lapps, who gazed with astonishment on the strangers who had travelled so far, and on the wonderful appliances they had brought with them. Many of these Arctic inhabitants were, however, sufficiently sophisticated to be provided with the traditional pieces of smoked glass with which to make their own observations.

The sun could not be seen at the moment when the moon first made contact, though almost immediately afterwards it was visible with a slight encroachment on the brilliant edge, showing that the eclipse had commenced. For nearly an hour hope and fear then alternated. Everything, of course, depended on the condition of the sky at the moment of totality, and it was hoped that some of the characteristic phenomena of a total eclipse might be presented. This hope was strengthened as the crescent sun waned thinner and thinner and still remained visible.

As the supreme moment of totality approached, the broad landscape sensibly darkened, and the fiord became more gloomy. It was as if some mighty thunder-shower was about to descend; but, alas! the clouds again thickened, and the observation of the moment of actual totality, if effective at all, could only be made by glimpses with a telescope through a very dense medium. Some observers were, of course, constrained to limit their attention to their instruments, and to the sole discharge of the duties which had been entrusted to them. But many were in the position of being able to look at the sun until the crescent of light was about to disappear, and then face round to the opposite point of the horizon. The object of this manœuvre was to permit the observer to see the impressive spectacle of the advance of the lunar shadow over the earth.

The situation at Vadsö lent itself admirably to the observation of this magnificent phenomenon. As the shadow advanced across the fiord, it enveloped the training squadron as it lay at anchor, the details of the ships' rigging disappeared from view, and their lights gleamed forth brilliantly. Still the shadow pressed on with its majestic speed of a mile in every couple of seconds. It moved as swiftly as a cannon-ball until it reached the observers at Vadsö, and then announced to them in the most impressive manner that the supreme moment of their visit had arrived, and that totality was complete.

The darkness that then buried Vadsö and its numerous observers lasted for a minute and forty seconds. The unwonted spectacle hushed every one to silence. A few startled birds hurried past the camp, and amid the canopy of cloud which covered the heavens at least one observer descried a star. But, though all the visitors felt that the magnificent phenomena were worthy of being remembered as a life-long experience, yet it is none the less true that, from a scientific point of view, the result of all the labours at Vadsö was hardly anything.

The object of the astronomers, who erected at such vast pains great photographic instruments, was to depict the corona and to analyse with spectroscopes the light which it dispenses. It is true that during the time of totality they exposed their plates in accordance with the careful drill and organisation which were indispensable if full advantage was to be taken of the brief period. But, unfortunately, during the time of totality the clouds were obdurate, and nothing could be seen. The innumerable telescopes directed to the sun showed no more than the same instruments would have done if they remained still covered.

The 100 seconds fled, marked only by the mechanical precision of the officer who counted them aloud. The astronomers might safely spare glances to the interesting view over land and sea. The light around them was not greater than that during a full moon, but in the distance mountain-tops could be descried which were not in the shadow and were shining brilliantly.

At last the darkness lifted, and the manner in which the light returned was almost startling in its suddenness. It was not that the sun became visible—this, indeed, did not at first happen—but when the moon had passed by, and when totality was over, the sun illumined the clouds, and this gave again the usual light of cloudy day when the orb itself is invisible. A few seconds later a glimpse was afforded of the crescent form of the sun, and then the clouds closed in once more, and did not withdraw until long after the moon had passed away from the disc.

THE PHYSICAL LABORATORY AT LEIDEN (HOLLAND).

WHEN a few years ago it appeared advisable to Prof Kamerlingh Onnes, the Director of the Physical Laboratory at the University of Leiden, to start the issue of a periodical paper which would contain a regular account of the research work that was going on in his laboratory, he decided upon the English language as being for various reasons the most suitable for the purpose. The "Communications from the Physical Laboratory at the University of Leiden" consist, as a rule, of more or less happy translations of contributions by Prof. Onnes and his pupils to the *Proceedings* of the "Koninklijke Akademie" of Amsterdam. They give short accounts of the researches that are carried out, and contain theoretical notes, as a rule, in direct connection with the experimental work. The full accounts of the investigations are mostly to be found elsewhere in various French, German or English periodicals.[1] No. 23 of the series appeared lately, and the whole set, containing everything that has been done in the laboratory since 1885, is now complete.

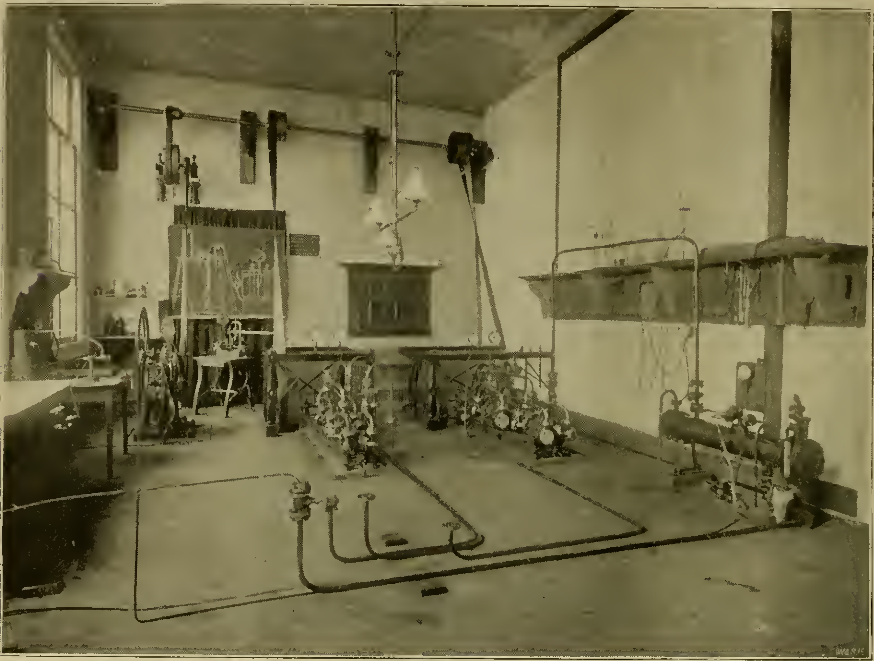
The most important characteristic which distinguishes the Leiden laboratory from most of its contemporaries is its installation for high-pressure and low temperature work. There are probably only one or two more places where an installation of this kind is permanently joined to a well-provided physical laboratory. Nos. 14 and 23 (especially the former) give a general idea of its gradual development and present arrangement.

Ever since 1883 Prof. Onnes has been working at this department. His object was in the first place to develop and improve the methods introduced by Cailletet, Pictet, Wroblewski, Olszewski, and to prepare larger quantities of liquid oxygen than before, so as to be able to decant it and use it as a cooling agent for experiments, especially on the liquefaction of hydrogen. The same object was, during the same years, striven after by Pictet, Olszewski and, in this country, by Dewar. Owing to want of sufficient funds and personal assistance, the work progressed very slowly, and it was not till June 1892, that a small quantity of liquid oxygen was decanted, while in December 1893 half a litre was obtained. It is interesting to notice how entirely independent the Leiden work is from the others. In the first place, Prof. Onnes uses Pictet's cycle method, while Olszewski developed the method used by Wroblewski in conjunction with himself. Instead of sulphurous acid, used by Pictet, he introduced methylchloride in the first cycle (a suggestion of Cailletet's), while ethylene remained

[1] *Archives Néerlandaises, Wiedemann's Annalen, Beiblätter, Zeitschrift für Physikalische Chemie, Philosophical Magazine.*

the second substance. Both substances are in continual circulation in metallic, self-contained cycles, which are worked by two Pictet conjugated pumps. While Olszewski introduced a steel cyclinder in which to liquefy oxygen, Prof. Onnes devised an "ethylene boiling flask" in which oxygen (or air) is condensed in a copper spiral. The glass apparatus into which the oxygen is poured is of original construction, and especially adapted for experimental work in oxygen (or air) baths of $\frac{1}{4}$ to $\frac{1}{2}$ litre.

Sometimes instead of the methylchloride cycle solid carbonic acid is used. Experiments on the insertion of a methane cycle between the ethylene and oxygen, with the ultimate object of condensing hydrogen, are still being carried on. Oxygen and air are taken from high-pressure cylinders, into which they are compressed either by a Brotherhood compressor (as used in launching torpedos) into a kind of model "cryogenic laboratory," as Prof. Onnes calls his creation, with emphasis on both cryogenic and laboratory. Occasional comparisons with other cryogenic installations illustrate this vividly. Dewar works with quantities of ethylene up to "a hundredweight" (40 kg.), while Prof. Onnes requires 1·5 kg., by aid of which $\frac{1}{4}$ to $\frac{1}{2}$ litre of oxygen is kept liquid. Pictet estimates the power required for experiments with liquid air at from 30 to 40 h.p., while in the Leiden laboratory only six or eight are required, even in exceptional cases. Olszewski gives his power as 1–3 h.p., but it must not be forgotten that his system is not a continuous one, and that the largest quantity which his apparatus in its enlarged form yields is 200 cc., only $\frac{1}{3}$ of which gets into his boiling-glass. His experiments require a correspondingly smaller quantity of ethylene (1 kg.).



View of the cryogenic department in 1887, showing the compressors destined for the chlormethyl, ethylene, and oxygen cycle. At the right the chlormethyl condenser.

or by a much less powerful, but in other respects highly superior Cailletet compressor. This compressor as modified, almost re-designed by Prof. Onnes, is a most desirable laboratory apparatus where high-pressure work with pure gases is being done. The chief modification is that the mercury column works in a steel U-tube, so that the piston with its lubricant (glycerine) is on one side above it, and the valves, &c., on the other. This compressor may be fully depended upon; the gases remain just as pure as they were, and may be compressed to 100 atmospheres without loss. (A full description of this compressor may shortly be expected.)

It is worth noticing that the greatest possible care is taken (and had to be taken) in the way of safety and of economy; these circumstances make the department

It need hardly be said that these low figures have only been arrived at by a slow process of trial and gradual improvement, and one cannot but admire the perseverance and skill which the development of this system reveals.

Now that the cryogenic department is so far completed that baths of liquid oxygen and air may be readily prepared, no doubt the co-operation with the rest of the laboratory will become more regular and fruitful. Even now, in reading through the "Communications," we come repeatedly across instances in which the high-pressure and low temperature appliances have given invaluable help.

At one time, for instance, pure oxygen was required for experiments on the magnetic rotation in gases at high pressure (Nos. 7, 15). Commercial oxygen being too

impure for the purpose, the preparation of a cubic metre of oxygen was undertaken. The gas was prepared by electrolysis, conducted through purifying apparatus, and compressed into a steel cyclinder of 10 litres capacity, at a pressure of 100 atmospheres by the mercury compressor. The gas in the cylinder appeared to contain nearly 99 per cent. of oxygen. How many laboratories exist in which such a thing could be performed?

As to low temperatures, in No. 6 we notice the measurement of the capillary elevation of ether at -102° in boiling ethylene; in No. 18, of the same magnitude for carbonic acid and nitrous oxide at -24° in boiling methylchloride. Nos. 4, 16, 18 contain the description of a method for purifying gases by condensation and fractional distillation at low temperature, in a bath of ethylene or in solid carbonic acid, the gases purified being carbonic acid, methylchloride, nitrous oxide, and ethane. Finally, we may note the measurement of the viscosity of methylchloride at -30° in cooled alcohol.

The different investigations hitherto carried out may be arranged under the following headings.

I. Cryogenic department: condensation of methane, isothermals of hydrogen at low temperatures, &c. (Nos. 14, 23.)

II. Investigations regarding critical points and condensation of mixtures and of pure substances. (Dr. Kuenen. Nos. 4, 7, 8, 11, 13, 16, 17.)

III. Measurements on the capillarity of ether, carbonic acid, nitrous oxide, &c. (Drs. de Vries and Verschaffelt. Nos. 6, 18.)

IV. Measurements on the viscosity of methylchloride in connection with the laws of corresponding states of matter. (Drs. Stoel and de Haas. Nos. 2, 12.)

V. Series of experiments on Kerr's magneto-optical phenomenon, &c. (Drs. Sissingh, Wind and Zeeman. Nos. 1, 3, 5, 8, 9, 10, 15, 20.)

VI. Some experiments regarding Hall's phenomenon in bismuth. (Dr. Lebret. Nos. 15, 19.)

VII. On Hertz-waves in water and in electrolytes. (Dr. Zeeman, partly in conjunction with Prof. Cohn, Strassburg. Nos. 21, 22.)

VIII. Observations on the dispersion of magnetic rotation in gases. (Dr. Siertsema. Nos. 7, 15.)

The scope of this article does not allow of a further description or discussion of any of the above investigations. One instance will show the scale on which the experiments are carried on, if deemed necessary. For the observations mentioned under VIII., two coils were constructed, each of 1 metre length and with 3600 turns of 6 mm. wire, the joint resistance of the coils in series being 1 ohm, and the current carried 70 amperes.

Besides a dynamo there are two or three sets of accumulators, which make it possible to work simultaneously at two or three investigations for which strong currents and electric lamps are required. In short, the place is rich in apparatus of all kinds, and possesses numerous appliances; so much so, that one would rank it amongst the best provided (and, one may add, most productive) research laboratories. It is worth observing, that in Holland private munificence is hardly ever directed towards scientific work, and that the whole of this laboratory, as of all the others in the three Government Universities—Leiden, Utrecht, Groningen—are kept up from the public purse. It is only recently that, under the strain of the competition between the Universities, private societies have been founded to promote University work, where the Government shows itself unwilling or unable to provide the necessary means.

Those to whom these "Communications" are unknown, and who are desirous of becoming more intimately acquainted with their contents, have only to apply for copies to receive them. Prof. Onnes will, moreover, be very glad if physicists, touring in Holland, would alight at the famous University town, and in their programme include a visit to his laboratory.

THE GREAT RIFT VALLEY.[1]

IT is but rarely that a narrative of travel, however interesting it may be, and however exciting the adventures of the author may have proved, has as much attraction for naturalists and geologists as the present volume possesses. Dr. Gregory has shown himself a thoroughly competent explorer, for he succeeded in reaching the glaciers close to the summit of Mount Kenya, the highest peak of British East Africa, a task in which several previous travellers had failed; and he also examined a considerable length of the extraordinary tract that gives its name to the book before us. This, too, was accomplished with a much smaller caravan than was regarded by experienced men as necessary for safety; in face of difficulties, due to the proclivities of the natives and to scarcity of food, that would have daunted many men; in spite of the utter failure of the expedition to which the author was originally attached; and, above all, despite severe attacks of malarial fever and dysentery. "The Great Rift Valley," apart from its scientific interest, gives a very interesting account of an adventurous exploit, carried out with courage and firmness, and, at the same time, with kindly treatment of the natives employed and encountered.

It is, however, not as a record of exploration alone that this book needs notice. Explorers equal to Dr. Gregory in courage and tact, and perhaps superior to him in the power of resisting malarial influences, have made their way through many of the forests and deserts of Africa, and have told some of the secrets of the Dark Continent to an appreciative audience; but very few of those who returned to tell the tale of their adventures possessed the scientific training that gives an especial value to Dr. Gregory's account of his travels. In this respect the author of the present work is singularly qualified. In the era of specialisation in science that we have now entered upon, it is becoming rare to find a geologist who knows anything of zoology or botany, or a zoologist or botanist who can tell schist from shale or sandstone from granite; whilst it appears to be rapidly becoming a point almost of honour with the geologists, zoologists, and botanists of the British Islands to regard palæontology as an inferior science. It is therefore noteworthy that Dr. Gregory, who is a palæontologist, should have brought back from Eastern Africa a mass of observations that could not have been accumulated by a geologist ignorant of biology, nor by a zoologist or botanist unacquainted with geology.

Briefly the history of the journey described is this. In November 1892, Dr. Gregory received leave of absence from the Trustees of the British Museum to enable him to join an expedition to Lake Rudolf. From various causes this expedition was a failure. After the dispersal of its members, Dr. Gregory went on to Mombasa, where he engaged a small party of porters, and in March 1893 started for Lake Baringo and Mount Kenya, and succeeded in reaching both. The journey occupied five months, and the expedition returned to Mombasa in August.

The arrangement of the present work is the following. After an introduction, giving a general account of previous exploration, and of the geology of the area as known before the author's visit, the first three chapters relate his experience with the abortive expedition which started from Lamu to explore Lake Rudolf and the regions between that lake and the Red Sea, but never got beyond the lower reaches of the Tana River; then eight chapters contain a description of the journey to Baringo and Kenya; and the third part of the book, comprising

[1] "The Great Rift Valley: being the Narrative of a Journey to Mount Kenya and Lake Baringo, with some Account of the Geology, Natural History, Anthropology, and Future Prospects of British East Africa." By J. W. Gregory, D.Sc., F.G.S., F.R.G.S., F.Z.S., of the British Museum (Natural History). (London: John Murray, 1896.)

seven chapters and three appendices, affords a general summary of the scientific results.

The "Great Rift Valley," of which the characters were first indicated by Suess, is a fissure in the earth's surface into which, or into portions of which, a strip of the surface itself has been let down by parallel faults. The cliffs formed by the faults have not been removed by denudation, and the necessary inference is that the dislocation—partially, at all events—is of small geological antiquity. The great fissure itself is regarded as similar in character to certain lines, resembling cracks, that have been observed on the moon's surface; it has been traced at intervals from the valley of the Zambesi to Lake Rudolf, and it is supposed to be connected through the trough of the Red Sea with the depression containing the Jordan Valley and the Dead Sea in Palestine. From Lake Rudolf a branch rift appears to diverge to the west, and to lead through Lakes Albert and Albert Edward to Tanganyika; whilst south of Lake Rudolf the eastern branch, our knowledge of which has been materially increased by Dr. Gregory's examination, contains several smaller lakes—Baringo and Naivasha, amongst others—and probably terminates to the southward in Lake Nyassa. Altogether this wonderful north and south trough is regarded as having a length of 4000 miles, and is said to contain thirty lakes, of which only one has an outlet to the sea. Evidently only the eastern branch of the rift is referred to, fo :three large lakes in the western branch—the Lakes Albert, Albert Edward, and Tanganyika are drained by the Nile or the Congo.

The principal additions to our knowledge of the "Great Rift Valley" are two in number. Dr. Gregory has shown, apparently beyond any chance of error, that the portion of the valley examined by him—fifty to seventy miles on each side of the equator, or about 120 miles in all—is actually let down by faults on each side. He has also shown that great changes in elevation must have occurred throughout the area in comparatively recent geological times, and that one of these led to the formation of a large lake, of which traces are left in the form of terraces on some of the scarps that bound the Rift Valley. To the ancient lake Dr. Gregory applies the name of Lake Suess; and, if a name is required, no more appropriate one could be devised.

The discoveries on Kenya were even more important than those in the Rift Valley, for not only did Dr. Gregory find glaciers, but he met with clear evidence that these glaciers formerly descended more than 5000 feet lower down the mountain than they now do. Reasons are given—one of the most important being the absence of any similar evidence on Kilimanjaro—for doubting whether the former extension of glacial action on Kenya was due to a general refrigeration of the earth's surface in the glacial epoch, and it is inferred that Kenya and the surrounding area have undergone depression since the period of maximum glaciation on the mountain. This may be the case, but it leaves the great difficulty of the whole question unexplained; we have still to account for the isolated occurrence of temperate plants, both of northern and southern types, on all the Central African mountains.

A considerable mass of interesting details on the geology of the country lying between the coast and the Rift Valley is given, and incidentally, with reference to the great lava plains traversed, their origin is discussed and a theory put forward to account for the phenomena.

FIG. 1.—The Eastern Wall of the Rift Valley, with the Terraces of Lake Suess.

It may, however, be doubted whether this theory, which its author terms that of plateau eruption, is really different from the explanation of the so-called fissure eruptions given in Sir A. Geikie's text-book.

It is when we pass from the purely geological chapters to those portions of the work that refer to the East African fauna and flora, and to the descriptions of the various tribes who inhabit the country, that we come to what will probably prove to many readers the most attractive portion of Dr. Gregory's work. The pages relating to the present and past distribution of life teem with original suggestions, and many of the observations made on the journey are highly novel and interesting. Amongst these are some curious cases of mimicry, especially that represented in the frontispiece to the volume, in which a group of hemipterous insects, red and green, presents an astonishing similarity to a flower-spike. Remarkable examples are given of the disappearance of wild animals, such as buffaloes and giraffes, throughout a very large tract of country, in consequence of disease; whilst observed instances of the destruction of great numbers by drought, and the accumulation of their skeletons around isolated water-holes, are suggested as perhaps accounting for some of the enormous masses of mammalian bones that are found imbedded in particular strata. It is not necessary to agree with suggestions of this kind in order to recognise their value; and unquestionably under the conditions pointed out, if the bones are, soon after the death of the animal, enclosed in silt or gravel, they may be preserved. Bones exposed on the surface, however, especially in the tropics, decay and break up with great rapidity, and the accumulations of fossil bones occasionally found are more probably due to carcases, carried down by a river flood, having collected in a backwater or on a sandbank.

One example of a suggestion of the author's, peculiarly illustrative of his double range of investigation, as geologist and as biologist, may here be noticed. It has long been known—we are indebted to Dr. Günther for the original facts—that the fresh water fish-fauna of the Jordan and Sea of Galilee resembles in certain peculiarities, such as the presence of the genus *Hemichromis*, that of the Central African lakes more than that of Northern Africa and of the lower Nile basin. Dr. Gregory shows the possibility of the Red Sea depression having once been the valley of a river flowing into the Indian Ocean, and receiving near its mouth a tributary from the large lakes that formerly existed in the Rift Valley, and that may have occupied a considerable portion of what is now the upper Nile basin. This is of course, as is fully admitted, hypothesis, but it is supported by a very curious mass of data, and it explains the difficulties better than any other suggestion hitherto put forward.

One characteristic of Dr. Gregory is a taste for naming various things, past and present. In many cases this is useful, as when he maps and names the ridges and valleys of Mount Kenya. It may also be of service to have a name, like Lake Suess, for an ancient sheet of water of which evident traces remain; but it is somewhat questionable whether there is any advantage in calling the hypothetical stream, that may at some past time have traversed the Red Sea, the Erythraean river. In one case the author of the "Great Rift Valley" appears, in the application ot names, to have departed from the usual practice. Geologists have generally given local names to rock-systems and their divisions, and have referred them, so far as they were able, to the geological periods, or divisions of geological time, recognised in Europe. To judge by the table at p. 235, certain names—Naivashan, Laikipian, &c. —are given to divisions of geological time rather than to rock-masses, and it is fairly open to grave

Fig. 2.—Two Wa-pokomo of the Tana.

doubt whether this is an improvement on the usual practice.

The chapters on the flora of East Africa, and those on the Zanzibari and other natives of the country, contain a large amount of information, and are thoroughly readable. The same may be said of the concluding chapter on the national movements and future prospects of British East Africa. The whole book is clearly and well written and liberally illustrated, and the author, who quotes—and quotes appositely—not only Shakespeare, Byron and Göethe, but also Carlyle, Buckle, and Rudyard Kipling, has evidently gleaned widely in literary as well as in scientific fields. W. T. BLANFORD.

THE MEETING OF THE INTERNATIONAL COMMITTEE OF THE CARTE DU CIEL.[1]

AT the fourth meeting of the International Committee of the Carte du Ciel, which took place at the Paris Observatory in May, under the presidency of M. Tisserand, the following members were present: MM. Anguiano, Bailland, Bakhuyzen, Christie, Donner, Duner, Gill, Henry (Paul), Henry (Prosper), Loewy, Rayet, Ricco, Trépied, Turner, Viniegra. There were also present at the invitation of the Permanent Committee, MM. Abney, Backlund, Bouguet de la Grye, Callandreau, Common, Cornu, Downing, Fabre, Faye, Gautier (P.), Jacoby, Knobel, Laïs, Laussedat, Newcomb, Perrotin, Scheiner, Stephan, Wolf.

Of the eighteen observatories associated for the production of the Carte du Ciel, thirteen were represented. The directors of the five other observatories, MM. Russell (Sydney), Baracchi (Melbourne), Obrecht (Santiago), Cruls (Rio Janeiro), Beuf (La Plata), were prevented from attending by great distance or by professional duties.

The following officers were elected: President, M. Tisserand; Vice-Presidents, MM. Bakhuyzen and Gill; Secretaries, MM. Donner and Trépied.

The following resolutions were adopted:—

I.—*Photographic Catalogue.*

1. The Committee is of opinion that the probable error of the value of the rectilinear coordinates measured on the plates should be reduced to the smallest possible limits, and that the measurements must be directed in such a way that this probable error shall never exceed 0″·20.

2. (*a*) The Committee thinks it necessary to publish the rectilinear coordinates of the photographed stars as soon as possible.

(*b*) It is desirable that this publication should include the necessary information for the conversion of the results into equatorial coordinates.

(*c*) The Committee desires that a provisional catalogue of right ascensions and declinations should be published by those observatories which have sufficient funds at their disposal.

3. Each observatory will be at liberty to choose the positions of the comparison stars in the catalogues which seem to them most suitable. For the calculation of the constants of a plate, a minimum of ten comparison stars should be adopted if possible. The adopted positions of these comparison stars will be published.

4. The question of determining whether, for the reduction of the stars to 1900, it would be advisable to adopt a uniform system of constants for the observatories, will be the subject of a subsequent discussion.

5. The Committee recommends the adoption of a uniform size of publication for all the observatories; the size should be that of the volumes of the Catalogue of the Paris Observatory.

[1] Abridged from the *Bulletin Astronomique*, July 1896.

6. The observatories will be at liberty to determine the photographic magnitudes, either by measurements or by estimation. The only condition which the Committee thinks it necessary to impose, is that the system of photographic magnitudes on which the measures or estimations depend, should allow of a precise definition, so that the different scales used in the different observatories can be reduced to a common system.

II.—*The Photographic Chart.*

7. Every observatory will be provided with a scale of density, which will be printed on the plates at the same time as the *réseau*, and which will permit the determination of the sensibility of each plate for luminous sources of different intensities.

Captain Abney is charged by the Committee with the construction of the scales.

8. For the construction of the chart, the second series of negatives (that is to say, those of which the centres have odd numbers for their declinations) will be made in three exposures, each lasting thirty minutes. This time of exposure may, of course, be reduced if an increase of the sensibility of the photographic plates be secured.

9. The Committee allows photogravure on copper as a means of reproducing the chart. The negatives to be exposed three times, and enlarged to twice the original size.

10. The observatories will make two positives on glass by contact, one of which will be placed in the Pavillon de Breteuil, the headquarters of the International Bureau of Weights and Measures.

11. The Committee defers till the next meeting the examination of the measures which it may be necessary to take with the object of assisting those observatories which may anticipate a difficulty in completing their programme.

The meetings of the Committee were marked with the greatest cordiality, and with the desire to carry to the end the great work undertaken in common; the decisions, prepared by special sub-Committees, were passed unanimously by the members present.

The Conference was followed by a soirée on Saturday, May 16, and by a dinner given the next day (Sunday, May 17), in the large gallery of the Observatory, at which the following were present: MM. Rambaud, Minister of Public Instruction; Bertrand and Berthelot, Permanent Secretaries of the Academy of Sciences; Cornu and Chatin, President and Vice-President of the Academy; the members of the Committee, and numerous visitors belonging to the Academy, the Bureau des Longitudes, the Council of the Observatory, and the *personnel* of the establishment. Prof. Backlund, Dr. Downing, and Prof. Newcomb, members of the Conference on fundamental stars, were also present.

NOTES.

LIEUTENANT DE GERLACHE announces that the Belgian Antarctic Expedition he has been organising for some time past will not be sufficiently advanced to start before next year.

M. EUGÈNE TISSERAND will shortly retire from the post of Director-General of Agriculture in France, after forty-six years of public service.

EXTREMELY hot weather is reported from North America. In New York, on Tuesday, the shade temperature reached 97° F. As many as 226 deaths are recorded as being directly due to this abnormally high temperature. In Chicago there were fifty-one deaths on Monday, and twenty-five on Tuesday. Hundreds of dead horses are said to be lying in the streets. The thermometer registered 96° F. at Ottawa.

THE deaths are announced of Dr. Kanitz, Professor of Botany in Klausenberg University, and Dr. Simony, formerly Professor of Physiography at Vienna.

OWING to a doubt having arisen as to whether the publication of *Climate and Health* was authorised by the Act appropriating to the U.S. Department of Agriculture the grant for the fiscal year ending June 30, 1897, that valuable repertory of statistical and other information relating to climatology and its connection with hygiene, has had to be discontinued. The special papers intended for it will be published in separate bulletins.

THE opticians of Pennsylvania are endeavouring to form a State organisation, having for its objects, first, the elevation and advancement of the profession and the mutual intercourse and benefit of its members; second, to encourage opticians to perfect themselves in the study of optics and the scientific adaptation of lenses in correcting errors of refraction; and, third, to discourage the haphazard and indiscriminate sale of spectacles by irresponsible and ignorant persons. British opticians might with advantage follow the lead of their Transatlantic brethren.

THE fifteenth Congress of the Sanitary Institute will be held at Newcastle-upon-Tyne, from September 2 to September 9. An inaugural address will be delivered by Earl Percy, and lectures will be given by Dr. A. Wynter Blyth and Sir Charles A. Cameron. The Sections and their Presidents are: (1) Sanitary Science and Preventive Medicine; President, Prof. W. H. Corfield. (2) Engineering and Architecture; President, Sir Andrew Noble. (3) Chemistry, Meteorology, and Geology; President, W. H. Dines. There will be conferences of port sanitary authorities, medical officers of health, municipal and county engineers, sanitary inspectors, and on domestic hygiene. Excursions and visits to places of interest will be made during the Congress, and particulars with reference to them will shortly be made known. The Health Exhibition, held in connection with the Congress, will be opened by the Duke of Cambridge.

THE summer meeting of the Institution of Junior Engineers will be opened on Saturday at Edinburgh. After visiting the Forth Bridge and a number of industrial works, the members will leave on Tuesday next for Glasgow, where many places of engineering interest await their inspection. In the afternoon of the same day the members will be received in the Municipal Buildings by the Lord Provost and the Corporation, afterwards being entertained to an excursion to visit one of the new reservoirs of the Glasgow Corporation Water Works. On Wednesday there will be an excursion to Dumbarton, and a reception by the Provost and Town Council. An excursion will take place on Thursday; and on Friday various works will be open for visiting, the selection being left with the members. In the evening of Friday, the Institution's summer dinner will be held at the Alexandra Hotel, Glasgow, the President, Mr. Archibald Denny, in the chair, and Lord Kelvin the guest of the evening.

IN the *Bulletin* of the University of Wisconsin (Engineering Series, vol. i. No. 9), Mr. G. A. Gerdtzen discusses in a very complete manner the relative advantages of gas, steam, and electricity for the supply of heat, light, and power for domestic purposes. Electricity gives a perfect solution of the problem considered apart from expense, but practically it is out of the question for heating purposes. Although most of the European work on the subject is mentioned and discussed, the chief interest of the paper lies in the details of American practice. Stress is laid by the author on the altered conditions due to the extensive introduction of incandescent gas-burners.

THE following are among the exhibitions at present open, or which will be opened in various parts of the world before the end of the century. 1896: Odessa, Industrial and Fine Arts; Prague, International Pharmaceutical; Cannes, International; Rouen, National and Colonial; Geneva, National; Berlin, Industrial; Kiel, Maritime and Fisheries; Mexico, International; Exhibition at Para; Exhibition at Johannesburg; New York, Electric; Barcelona, Industrial Arts; Denver (Colorado), International Mining and Industrial; Vienna, Agricultural Machinery; Nijni-Novgorod, National; Innsbruck, Hygienic; Lyons, Exhibition of Natural Hygiene; London, Motors and Automatic Carriages. 1897: Brussels, International; Hamburg, International Horticultural; Rio Janeiro Exhibition; Guatemala, Central American; Exhibition at Brisbane; Exhibition at Stockholm; Montreal, International; Nashville (Tennessee), International Industrial and Fine Arts. 1898: Amsterdam, Universal; Exhibition at St. Paul, Brazil; Exhibition at Turin. 1899: Exhibition at Adelaide. 1900: Universal Exhibition at Paris.

BY the death of Mr. H. J. Slack, at the advanced age of seventy-eight, science has lost one of its most keen journalistic champions. In years when headway had to be made against prejudice and even antagonism, his enthusiasm inspired many younger workers, and he saw in the spread of science one of the great factors of social progress. For many years he edited the *Intellectual Observer*, which passed later into the *Student*, a journal which to him was largely a labour of love, and which, by its attractive form, had a wide educational value. His own researches were mostly in microscopy, and he was successively Secretary and President of the Royal Microscopical Society. Forty-six papers are ascribed to his name in the Royal Society's Scientific Catalogue; and his work entitled "The Marvels of Pond Life," passed through three editions between 1861 and 1878. In 1879, as President of the National Sunday League, Mr. Slack organised popular lectures for Sunday evenings in London, and did much to inaugurate that movement in furtherance of a rational Sunday, which has now gone so far as to receive parliamentary recognition. He was one of those who combined devotion to science with a broad sense of public needs; for him, science had its duties as well as its rights; and few can have come in contact with him without being the better for his cheerful and unflagging zeal in the causes which he had at heart. He was born on October 23, 1818, and died in his house at Forest Row, Sussex, on June 16, 1896.

A BILL to legalise the use o. weights and measures of the metric system in this country was read for the first time in the House of Commons on July 30. The Bill is as follows:—"I. (1) Notwithstanding anything in the Weights and Measures Act, 1878, the use of a weight or measure of the metric system in trade shall be lawful, and nothing in section nineteen of that Act shall make void any contract, bargain, sale, or dealing by reason only of its being made or had according to weights or measures of the metric system. (2) A person using or having in his possession a weight or measure of the metric system shall not by reason thereof be liable to any fine. (3) For the Third Schedule to the Weights and Measures Act, 1878, shall be substituted the Schedule to this Act. II. Section thirty-eight of the Weights and Measures Act, 1878, is hereby repealed, and the Board of Trade shall verify copies of metric standards in the same manner as if they were copies of Board of Trade standards, and the provisions of that Act relating to the verification of local standards shall apply accordingly. III. In section forty of the Weights and Measures Act, 1878, the expression 'local standards of weights and measures' shall include local metric standards and the provisions of that Act relating to local standards shall apply accordingly." The Schedule to the Bill gives a series of equivalents of metric and imperial weights and measures. The Bill will not be proceeded with this Session.

A return has been presented to Parliament showing the number of licensed experiments performed on living animals during the year 1895. The total number of persons holding licences was 213, but of these 65 performed no experiments. Tables are given which afford evidence (1) that the licences and certificates have been granted and allowed only upon the recommendations of persons of high scientific standing; (2) that the licensees are persons who, by their training and education, are fitted to undertake experimental work and to profit by it; and (3) that all experimental work has been conducted in suitable places. The total number of experiments performed in 1895 was 4679. In 1560 of the experiments performed the animal suffered no pain, because complete anæsthesia was maintained from before the commencement of the experiment until the animal was killed; 2358 of the experiments were practically always of the nature of hypodermic injections or inoculations. In 761 experiments the animal was anæsthetised during the operation, but was allowed to recover. These operations, in order to insure success, are necessarily done with as much care as are similar operations upon the human subject, and, the wounds being dressed antiseptically, no pain results during the healing process. The large number of inoculation experiments is, to a great extent, attributable to investigations connected with the production of diphtheria-antitoxins and analogous bodies. More than half of the experiments under Certificate B have been inoculations made (under anæsthetics upon rodents) with the object of diagnosing rabies, the public having largely acted upon the advice printed upon the back of dog licences, which is to the following effect: "If a dog suspected of being rabid is killed after it has bitten any person or animal, a veterinary surgeon should be requested to forward the spinal cord to the Brown Institution, Wandsworth-road (or some other licensed institution) in order that it may be ascertained with certainty whether the animal was suffering from rabies."

Prof. John Milne, writing from his observing station in the Isle of Wight in reference to the long series of earth disturbances commencing on June 29 in Cyprus (see Nature, August 6, p. 325), says that he also has recorded a long series of movements commencing on that date. Two alarming and severe shocks in Cyprus, in G.M.T., commenced on June 29 at *about* 8h. 48m. os., and July 2 at *about* 18h. 13m. os. The Isle of Wight records commence on the above dates at 9h. 02m. 26s. and 18h. 51m. 29s.

Prof. Dr. A. Gerland, in the *Zeitschrift der Gesellschaft für Erdkunde zu Berlin*, gives an account of the earthquake in South-western Germany on January 22, 1896. The disturbance was in many ways remarkable, extending as it did over an area of about 40,000 square kilometres; and it seems to have had its origin at a considerable depth below the surface, as the recorded times of its occurrence are nearly identical over the whole region affected. The disturbance lasted on an average about five seconds, and was apparently of the nature of a sudden shock in an east to west or west to east direction, although in Strassburg and Stuttgart it seems to have been vertical; affording an excellent illustration of the fact, pointed out by Prof. Schmidt, that the direction of displacement is not necessarily connected with the direction of propagation of the disturbance. A remarkable feature of the disturbed region is the occurrence of isolated areas which remained unaffected; this is especially the case in the Jura, Le Locle and La Chaux le Fonds being the only stations reporting even a slight shock.

The *Bollettino della Società Geografica Italiana* contains a note on some observations recently made by Dr. S. Angelini on the colour and transparency of the waters of the lagoon at Venice and of the Gulf of Gaeta. The depths at which white, green, red and blue discs, each 50 cm. in diameter, ceased to be visible from the surface, were measured with the following results:—

		White.	Green.	Red.	Blue.
Lagoon	Metres	1·98	1·85	1·80	1·50
Gulf of Gaeta	,,	8·50	7·80	7·00	6·00

The ratios of these numbers indicate a somewhat greater relative transparency in the waters of the lagoon for red and blue rays than for white or red.

Dr. A. Lindenkohl contributes to *Science* an abstract of a report on the work of American surveying vessels in the Gulf of Mexico and the region of the Gulf Stream during the last twenty years. The full memoir is to be published in the annual "Report of the U.S. Coast and Geodetic Survey" for 1895, and, amongst other important matter, includes a discussion of the sources from which the Gulf Stream derives its waters. It appears that the Gulf of Mexico supplies only a very small part of the whole, the currents entering and leaving it being inconsiderable both in volume and velocity.

Herr Friedrich Benesch contributes to the *Mittheilungen der K.K. Geographischen Gesellschaft in Wien* a short description of Pauliny's new method of drawing relief maps, which he says is a great advance on any method now in use, both in respect of accuracy and of ease in execution. The map is in effect a closely-contoured map, printed on silver-grey paper, the contour lines being white where illuminated by a source of light supposed to be 45° above the western horizon, and black elsewhere. Level plateaus and slightly sloping areas are thus represented by the natural grey colour of the paper; steep declivities towards the west are lightened by the closely drawn white lines, and towards the east correspondingly darkened by the black lines, the departure from the normal grey being greater the closer the lines, *i.e.* the steeper the slope. The method has the merit of giving a clear idea of *steepness* derived from the contour lines themselves; and while it does not demand the high standard of skill necessary in Lehmann's method of hachuring, the confusion produced by the shadows in some modern maps, where the illumination is supposed to come from the horizon, is avoided. Maps illustrating Herr Pauliny's method are to be published in Vienna in the course of the summer.

In the *Atti dei Lincei*, Dr. Vittorio Abelli describes a remarkable case which occurred in the course of a scientific expedition on the slopes of Monte Rosa. At an altitude of 4560 metres, a member of the party, twenty-two years of age, was suddenly attacked with pulmonitis, and subsequently completely recovered from the disease. This led Dr. Desiderio Kuthy, of Budapest, to carry on a series of experiments on the action of rarefied air on the *Diplococcus* of pulmonitis, and also on the *Pneumococcus* of Fraenkel. Two conclusions were drawn from these investigations: firstly, that rabbits after being inoculated with this *Pneumococcus* die more rapidly when they are surrounded by air at the reduced pressure corresponding to that on Monte Rosa; secondly, that this occurs although the *Pneumococcus* is less virulent when it is developed in rarefied air. In the case of the youth Ramella, Dr. Kuthy considers that the infection was mitigated in consequence of the attenuation of the *Pneumococcus* arising from the rarefaction of the air, but the same circumstance caused the attack to be more violent in spite of the mildness of the infection.

In the *Nuovo Cimento* for June, Dr. A. Fontana describes a new form of slide-rule designed for the purpose of shortening the calculation of the corrections which have to be applied when a body is weighed in air, and its weight *in vacuo* is required. The device bids fair to prove very useful in physical laboratories where weighings are constantly being made.

AT the conclusion of a lecture on the transformation of the energy of carbon into other available forms, recently delivered before the Franklin Institute by Mr. C. J. Reed, the Jacques cell, described in a note in these columns on July 30 (p. 298), was referred to. Several experiments were performed to show that the cell is a thermo-electric one. "It was shown (we quote the Society's *Journal*) that, at low temperatures, while the caustic alkali contained considerable water, the carbon was positive to the iron; but that at a high temperature, after the alkali had become highly dehydrated, the carbon was negative to the iron. The carbon rod was replaced, successively, by rods of brass, copper, German-silver, and iron, without appreciably affecting the result, and a current of illuminating gas was passed into the fused alkali in place of the current of air employed by Jacques. The result was unchanged, showing that the action of the current of air was not to produce oxidation, but to cool the upper layer of the alkali."

IF the stability of a nation is measured by the amount of care bestowed upon forests, the power of Germany is not likely to decline. Mr. G. A. Daubeny contributes to *Nature Notes* a chatty account of forestry in Germany, where more than twenty-five per cent. of the land is covered with trees. In Prussia, twenty-three per cent. is forest; but in England the proportion of forest land is small—only four per cent. There is quite an army of foresters in Germany—about twelve thousand in all—and, as is well known, these officials receive a thorough training in all the branches of their subject. Mr. Daubeny ascribes the decayed power of Syria, of Greece, and of Spain to the neglect of their forests, and urges the afforestation of land as a means of developing national resources. "Den Wald zu pflegen, bringt allen Segen," says a German proverb; and even if the care of forests does not bring every good, it adds considerably to the wealth of a nation.

UNDER the title "Publications of the Smithsonian Institution," by Mr. W. J. Rhees, a list of a number of papers printed from the Institution's Contributions to Knowledge, Miscellaneous Collections, and Annual Reports, for sale or exchange, has been issued. The papers are classified according to a comprehensive scheme of subjects, and are fully indexed. Every student of science will find in the list works which he will be anxious to possess.

WE have received from Messrs. Marcus Ward and Co. a small portfolio of forty coloured prints of common native and introduced plants found in Manitoba. There is no explanatory letter-press, and nothing to show whether there are more to come or not. All we can say for them is that the figures are tolerably well drawn, though often crudely coloured. Still they are recognisable, and may prove serviceable to persons who wish to know the names of plants growing in their neighbourhood.

LOCAL scientific societies keep alive the spirit of inquiry, but they often err on the side of dilettantism. We are afraid the *Proceedings* of the Bath Natural History and Antiquarian Field Club comes into this category, for though the number (vol. viii. No. 3) just received contains a helpful paper by Mr. A. Smith Woodward on the collection of fossil fishes from the Upper Lias of Ilminster, in the Bath Museum, and some notes of local antiquarian interest, there is also a description of an excursion to witness a diviner's experiments in water-finding. It would be well if societies like that at Bath would help more seriously to extend natural knowledge than many of them do at present.

TWO ponderous volumes of the "Palæontologia Indica"—a publication which, as every geologist knows, is devoted to the description and illustration of organic remains procured during the progress of the geological survey of India—have lately reached us. In one of them (Series xiii. vol. ii. part i.), Dr. William Waagen continues his work on "Salt-Range Fossils" by descriptions of the fossil contents of the Ceratite beds. These beds are believed to represent the Trias of Europe, but it is not possible to say exactly what parts of the Trias are represented by them, though Dr. Waagen's contribution will enable the question to be profitably discussed. The fossils which are obtained from the Ceratite formation of the Salt-Range are chiefly Cephalopoda, only a few remains of fishes having been found. The present volume contains the determinations of the genera of the few specimens available, but by far the greater part of it is devoted to the Ammonoids. The specific descriptions of the fossils, and the remarkably fine plates which illustrate them, will prove of prime importance in the further consideration of the classification of that order. In the definition of the genera and families treated by Dr. Waagen, the groups are minutely characterised, but the developmental connection is only kept in sight so far as it has been demonstrated. It is held that, in the present state of our knowledge, it is undesirable to do more than arrange the single genera according to their affinities in smaller groups, or families. Dr. Waagen's memoir will, however, enable the developmental relations to be more fully worked out than has previously been possible.

THE second memoir referred to in the foregoing note belongs to Series xv. of the "Palæontologia Indica." In it Dr. Carl Diener describes "The Cephalopoda of the Muschelkalk." The volume is a monograph on the Cephalopoda of the Muschelkalk—a distinct geological horizon in the Himalayan Trias, regarded by Dr. E. von Mojsisovics as a connecting-link between the triassic Mediterranean and Arctic-Pacific provinces. Dr. Diener has used a wealth of palæontological materials in preparing his work, and his interpretation of them is a valuable contribution to the knowledge of the triassic fauna of the Himalayas. In a third publication to which we must call attention (*Memoirs* of the Geological Survey of India, vol. xxvii. part 1), Dr. F. Noetling describes "Some Marine Fossils from the Miocene of Upper Burma." Sixty-nine species are described, and fifty-one have been determined. From these identifications it is seen that the fauna represents a marked Indian facies, slightly sprinkled with a more Southern element from Java.

AT the beginning of last year it was decided by the United States Congress that future annual reports of the Department of Agriculture should be divided into two volumes: first, an executive and business report; and second, a volume "specially suited to interest and instruct the farmers of the country," made up of papers from the Department bureaus and divisions. This latter volume ("Yearbook of the Department of Agriculture, 1895") has recently been distributed, and it will undoubtedly extend agricultural knowledge in the United States. In the first place, the volume contains a general report of the operations of the Department during 1895. Then there is a series of thirty-three essays by experts, discussing in easy language the results of investigations in agricultural science and new developments in farm practice. As years go on, successive issues of Yearbooks of this kind will give farmers a good library covering the applications of science to practical agriculture. In an appendix, a large amount of miscellaneous information, taken from the reports of the Department, is presented with especial regard to the agricultural reader. It is impossible for us even to enumerate the many papers contained in the volume. Valuable data, facts of interest, recipes, directions with regard to agricultural practice, and descriptions of the relation of forests to farms, insect pests, principles of pruning, soil ferments, common birds of the farm and garden, and co-operative

road construction are given in an instructive and interesting form. To quote the words of Mr. C. W. Dabney, Assistant Secretary of the Department: "It has been sought to make the volume a concise reference book of useful agricultural information based in great part upon the work of this and other Departments of the Government, without making it an encyclopædia of general information. In brief, the effort has been to make a book, and not a mere Government report—a book worthy to be published in an edition of half a million copies and at an expense to the people, if we count both publication and distribution, of over four hundred thousand dollars." The money thus spent in disseminating accurate knowledge of agricultural investigations may appear excessive, but it will be returned to the country a hundred-fold.

THE additions to the Zoological Society's Gardens during the past week include a Black-faced Kangaroo (*Macropus melanopus*, ♂) from Australia, presented by Mr. G. T. Wills; a Loder's Gazelle (*Gazella loderi*, ♀) from Oued Souf, Algeria, presented by Mr. A. B. Birdwood; a Gazelle (*Gazella* ——), two Hairy-footed Jerboas (*Dipus hirtipes*), a Spot-bellied Snake (*Zamenis ventrimaculatus*), an Ocellated Sand Skink (*Seps ocellatus*) from Arabia, presented by Dixon Bey; a Common Cormorant (*Phalacrocorax carbo*), British, presented by Miss G. Howell; two Passerine Parrots (*Psittacula passerina*) from South America, presented by Miss L. Scott Moncrieff; a Brown Capuchin (*Cebus fatuellus*) from Guiana, a Grey Ichneumon (*Herpestes griseus*) from India, deposited; two Patagonian Cavies (*Dolichotis patachonica*), two Ypecaha Rails (*Aramides ypecaha*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

BROOKS'S COMET.—This comet, which M. Javelle, of Nice, has fortunately re-discovered, remains so faint an object, that other observations for the improvement of the elements, computed by Dr. Bauschinger, are still wanting. The one position secured has been utilised to correct the mean motion, and consequently the time of perihelion passage. This will take place November 4·18375, Berlin mean time, or only 0·2083 days later than the time determined from the last appearance. The excentricity needs probably a small correction, but the data for its determination are not yet existing. The following ephemeris, for Berlin midnight, is derived from the corrected mean motion and time of perihelion passage.

1896.		R.A. h. m. s.	Decl. ° ′ ″	Brightness.
Aug.	13	22 32 43·50	−18 54 24·1	1·8
	16	30 58 66	18 59 1·0	1·9
	20	28 26·73	19 4 4·9	1·9
	24	25 44·87	19 7 30·7	2·0
	28	22 58·22	19 8 52·5	2·0
Sept.	1	20 11·78	19 7 49·1	2·1
	5	17 31·14	19 4 1·2	2·1
	9	15 2·04	18 57 10·7	2·1
	13	12 49·63	18 47 8·8	2·0
	17	10 58·23	18 33 53·0	2·0
	21	9 31·79	18 17 22·7	2·0
	25	8 32 66	17 57 45·6	2·0
	29	8 2·93	17 35 8·0	1·9

For finding the comet, the bright star Fomalhaut will still be convenient, the region comprised in the ephemeris being about 11° north of the star, and on the meridian (London) about 1·45 a.m.

METEOR TRAILS.—We noted on July 30 (p. 301) that attention has been called by Prof. Johnstone Stoney and others to the desirability of observing the meteors in November next, which are likely to form part of the great November shower, particularly with the view of settling the question of the date at which the shower was introduced into the solar system. Improved methods of observation might have been expected to furnish more accurate information, and lead to a closer approximation to the orbit. It is therefore disappointing to read in the Report issued by Dr Elkin, the Director of the Yale Observatory, that, notwithstanding repeated efforts, no photographic records of meteor trails have been secured. The apparatus was in use for the August meteors, but none were of sufficient brilliancy to impress themselves upon the film, which had become somewhat fagged by the strong moonlight. Other occasions were equally disappointing; but the Director is not discouraged, and in place of the two lenses now employed he hopes to substitute the complete battery of lenses for which the mounting was originally planned.

PERSONAL EQUATION IN OBSERVING TRANSITS.—The vexed question of the existence and necessary removal of personal equation in determining clock error has been attacked by Mr. R. H. Tucker, of the Lick Observatory. The particular form of the question to which Mr. Tucker has applied himself is that raised some years since by Prof. van der Bakhuyzen, of the effect of the brilliancy of the star on the time of transit determined by chronographic registration. Mr. Tucker placed over the object-glass four thicknesses of wire netting, which reduced the magnitude of the star 4·1 magnitudes, or, in other words, destroyed all but one forty-fifth part of the original light. The clock error was determined from the observations of stars, with and without the screen alternately, with the result that the faint stars were observed 0·037s. later than when seen at their full brilliancy. The correction to observed right ascension is −0·009s. for each magnitude, with a probable error of ±0·001s.

RECENT RESEARCHES ON RÖNTGEN RAYS.

THE subjoined summary brings together in a convenient form for reference a number of researches on Röntgen rays which have recently come under our notice. It will be seen that a large amount of detailed information with reference to the character and capabilities of the rays is being accumulated by investigators in various parts of the world.

Dr. A. Dupré, F.R.S., writes, under date July 29:

"The article by Mr. Benjamin Davies, in your issue of July 23, has recalled to my mind certain experiments of my own, made several months since, which may perhaps throw some light on Mr. Davies' results. I was then working with various vacuum tubes, and among others with an ordinary Geissler tube containing nitrogen, such as is used for obtaining spectra of gases. The capillary part of this tube gave a brilliant light, which had the power of inducing fluorescence of many substances, to a remarkable degree, the light falling direct on to the substance. The tube being in action, the screen covered with platino-cyanide of potassium fluoresced strongly ten feet from the tube, the active surface being towards the tube. This was, of course, to be expected, but, to my astonishment, the fluorescence was almost equally noticeable when the back of the screen was turned towards the tube, and remained so even when I interposed a book, a board, a sheet of tin-plate, or the human body between the tube and the screen. When, however, I placed my hand against the back of the screen, no trace of a shadow was noticeable; the same was the case when pieces of metal, or other objects opaque to the Röntgen rays were so placed. The screen all the while remaining strongly and uniformly fluorescent. This seemed to me to show that, whatever the nature of the rays producing the fluorescence of the screen, they could not be Röntgen rays; and I concluded that the fluorescence was really due to light striking the front, or active, surface of the screen after reflection, either from the walls of the room, or, perhaps, from the air. When accordingly all possibility of any light thus reaching the screen was excluded, all fluorescence was effectually stopped. Might it not be possible that in Mr. Davies' experiment the fluorescence of his screen was in part, at least, induced by rays reaching the active surface of the screen after reflection? Thus accounting for the fact that the hand cast no shadow whatever."

Mr. J. A. M'Clelland read a paper on the "Selective Absorption of Röntgen Rays" before the Royal Society on June 18. The experiments described in the paper were made to determine whether or not the Röntgen rays given off by a vacuum bulb were of a homogeneous nature, by examining the manner in which they are absorbed by different substances. The substance whose absorptive power was to be examined—say, a plate of glass—was placed so that the rays traversed it before falling on a charged disc, which was in connection with a pair of

quadrants of an electrometer. The disc was discharged by the rays, and the transparency of the substance was measured by the rate at which the spot of light from the electrometer needle moved across the scale. Sheets of tinfoil were then substituted for the glass, and the number—n, say—taken, such that the rate of discharge of the disc was approximately the same as with the glass. The rate of discharge was accurately measured in the two cases. The ratio of the rate of discharge with the glass to that with the n sheets of tinfoil gave a measure of their relative transparency to Röntgen rays. The rays were then made to pass through a number of sheets of tinfoil, and then through the glass, and the rate of discharge measured. The glass was removed, and the same n sheets of tinfoil as were formerly used put in its place, and the discharge again measured. The ratio of the rate of discharge in the latter two cases was a measure of the relative transparency of the glass and the tinfoil sheets to Röntgen rays which had been already screened by passing through tinfoil. If the Röntgen rays were all of one kind, the two ratios thus obtained should be equal, but a difference in the ratios could only be explained by assuming that the rays were not homogeneous, and that some were more readily absorbed by the tinfoil, and others by the glass or other substance used. Various substances were tested against tinfoil in this manner. With some there was no selective absorption, with others it was very marked. Glass gave none, with mica and paraffin the effect was small, with fuchsine, eosine, and a number of other substances the effect was very marked. A table, given in the paper, showed the results obtained with these and other substances. The author concluded that the Röntgen rays are of different kinds, and that the substances given in the table differ very much from tinfoil in their selective absorption. It is important to observe that these results were obtained with a vacuum bulb which was working extremely well and discharging the disc very rapidly. With another bulb, which was not nearly so efficient, no evidence of selective absorption could be obtained. The radiation from this bulb was homogeneous as far as could be determined by this experiment. With a third bulb, better than the last, but not so good as the first, selective absorption was obtained, although less marked than with the first bulb. It seems, therefore, that as a tube becomes more efficient the character of its radiation becomes less homogeneous.

The effect of Röntgen rays in discharging electrified bodies continues to form the subject of investigation of several Italian physicists, whose conclusions may with interest be compared with the results obtained by Prof. J. J. Thomson in this country. Prof. Emilio Villari (*Atti della R. Accademia dei Lincei*) enunciates the following conclusions, in support of which an elaborate series of experiments are fully described. (1) The discharge of a conductor in air, when provoked by Röntgen rays, takes place by an electrical convection of the particles of air set in action by the radiations. (2) The discharge is retarded if the surface of the electrified conductor exposed to the air is diminished by covering part of it with paraffin. (3) When the conductor is covered all over with paraffin placed in contact with it, the discharge stops almost immediately after it has been started by the Röntgen rays. A little electricity conveyed by the surrounding film of air charges the paraffin, and further discharge was prevented. (4) If the conductor is surrounded by air enclosed within a tube of paraffin, and subjected to Röntgen rays, the discharge at first takes place fairly rapidly, but subsequently proceeds extremely slowly. The electricity carried off as usual by the air suddenly charges the walls of the tube, and afterwards is dispersed with difficulty. (5) The electricity dispersed by the body can be collected on a tube of paraffin, as in the preceding case, or on an insulated metal tube surrounding the discharged body. This collected electricity can be observed with an electroscope, and it is, of course, of the same kind as that of the body. (6) Metal tubes, whether insulated or not, surrounding the electroscope, serve to condense on it the charges imparted to them. They retard the discharge produced by Röntgen rays, either on account of the quantity of electricity accumulated by them, or owing to their imperfect transparency to the rays.

Prof. Augusto Righi (*Atti della R. Accad. dei Lincei*) also *still* considers it "non proven" that any but a gaseous dielectric becomes a conductor under the influence of Röntgen rays, thus agreeing substantially with Prof. Villari. Prof. Righi, however, has discovered a source of error in his previous experiments, which, however, does not affect this result. If in front of the aluminium window of a leaden box containing the Crookes' tube, a large disc of lead is placed, and the charged body is situated in the geometrical shadow cast by the disc, it might be supposed that no discharge would take place; but such is far from being the case, except when the leaden disc is closely pressed against the window.

In the succeeding number of the *Atti dei Lincei* this deflection of Röntgen rays behind opaque bodies is discussed at considerable length by Prof. E. Villari, who claims to have recorded the phenomenon as long ago as March last. Observations were made on the discharge of an electroscope placed in different portions of the shadow cast by a plate of lead, and, moreover, photographic impressions were obtained upon a sensitive plate placed just inside the geometrical umbra. Signor Villari concludes, that in order to discharge an electroscope it is not necessary that Röntgen rays should fall directly upon it. The presence of air previously traversed by these rays is sufficient to promote the discharge—a result in accordance with one o Prof. Röntgen's original observations.

In a subsequent paper in the same publication, Prof. Righ proves that the discharge of electricity produced in air by Röntgen rays takes place by convection *along the lines of electrostatic force*. The experiments were made by means of an insulated conducting sphere placed in the presence of a disc of ebonite having its lower side covered by a metal armature. Between the two a cross of ebonite was placed, and the conductor and armature were oppositely charged. After exposing the whole to the action of Röntgen rays for a few minutes, the ebonite was dusted over with a mixture of powdered red-lead and sulphur, when the shadow of the cross appeared red on a yellow background. In another experiment a cylindrical conductor was substituted, and the shadow was produced by a strip of ebonite placed parallel with its axis. The observed position of the shadow agreed exactly with that calculated from the form of the lines of electrostatic force, which in this case were, of course, coaxial circles.

It should be observed, however, that if the phenomenon were one of *conduction* instead of convection, the discharge would still follow the lines of force, just as in Prof. Righi's experiments.

The same indefatigable observer (Prof. Righi) also discusses in the *Comptes rendus* a paper by MM. Benoist and Hurmuzescu, who find that, "if Röntgen rays can develop an electric charge . . . this effect does not exceed the order of magnitude of the electromotive forces of contact." Prof. Righi finds that the positive potential to which an insulated conductor is raised when Röntgen rays fall on it, *is precisely* of that order of magnitude. In the experiments of MM. Benoist and Hurmuzescu, the electrometer and the conductor experimented on were enclosed in an uninsulated metal case; in Prof. Righi's experiments the case was made to enclose the Crookes' tube, which was placed at a considerable distance from the conductor, so as to remove the latter as much as possible from the influence of all conducting bodies. It appears probable that both dispositions are equally good.

Under the title "Raggi Catodici e Raggi-X" (*Nuovo Cimento*), Prof. Battelli and Dr. Garbasso give a continuation of their researches bearing chiefly on the question of whether there is really an essential difference between Röntgen rays and kathodic rays. These writers are of opinion that the two kinds of radiations do not differ from one another in any more essential characteristics than those which enable us, for example, to distinguish two flames of different colour.

In a further contribution to the *Nuovo Cimento*, Prof. Battelli and Dr. Garbasso examine the resemblance between Röntgen rays and ultra-violet light in their power of dispersing electric charges. The experiments, which were made by employing alternately a Crookes' tube and a voltaic arc with the same disposition of apparatus, lead to the conclusion that although ultra-violet light acts on electrified bodies in the same manner as Röntgen rays, the modification produced in the surrounding air (in the case of ultra-violet light) is less pronounced and less stable.

An important point in connection with the debated nature of Röntgen rays is the determination of their wave-length, which has been successfully effected by Dr. L. Fomm, of Munich (*Sitzb. der Bayerischen Akademie*, xxvi. ii.). As these rays show no measurable reflection or refraction, the only way available was by diffraction. The Röntgen rays emanating from a large Hittorf tube were made to pass through a brass slit 0·5 mm. in breadth, and, after being diffracted by a second slit, were received on the photographic plate. The

width of the second slit could be varied from 0·1 mm. up to 2 mm., and with the former width an exposure of fifty minutes was required. As long ago as March last, Dr. Fomm obtained photographs showing interference bands, thus affording proof of the undulatory nature of Röntgen rays. By starting with a very narrow slit and gradually increasing its width, the interference lines approach closer together, until a dark line—the first minimum—appears in the centre. As the opening becomes still wider, this minimum gives place to a maximum with two minima, one at each side, and so on, and by means of Lommel's formula, the wave-length can be determined from this phenomenon. Dr. Fomm obtains $\lambda = 0.000014$ mm., so that the wave-length is about fifteen times smaller than the smallest wave-length hitherto observed in the ultra-violet. Owing to the difficulty of determination, Dr. Fomm regards this number as giving the upper limit rather than the exact measure of the wave-length of the observed rays. Meanwhile MM. G. Sagnac, L. Calmette, and G. T. Lhuillier have published investigations in the same direction (*Comptes rendus*, cxxii. 13 and 16). M. Sagnac uses a wire grating, and from a scarcely measurable diffusion of the image of the slit he obtains 0·00004 as an upper limit to the wave-length. MM. Calmette and Lhuillier have made diffraction experiments with two slits, and have obtained bright and dark lines without expressing an opinion as to the wave-length of the rays.

Another closely allied question is whether Röntgen rays consist, like ordinary light, of radiations whose wave-lengths vary over a considerable range. Such differences of wave-length give rise in the case of light to the phenomenon of colour, and the corresponding phenomenon for Röntgen rays has been studied by Dr. F.-V. Dwelshauvers-Dery (*Bulletin de l'Académie Royale de Belgique*, No 6) under the name of *actinochroism*. Observing that differences in the degree of exhaustion of a Crookes' tube might be expected to give rise to differences of wave-length in the emitted rays, and that the higher the vacuum the shorter would the wave-lengths probably be, Dr. Dwelshauvers-Dery has examined whether certain substances are more transparent for certain Röntgen rays than for others. For this purpose, their transparencies were compared by placing the substances in front of a fluorescent screen and observing their shadows side by side with that of a test-object consisting of laminæ of tinfoil, whose total thickness could be varied at pleasure. To obtain the necessary variation in the nature of the Röntgen rays, it was found sufficient to compare the radiations from a new tube, which had not been previously used, with those emanating after the tube had been in action for some time. The observations were repeated on the new tube after a quarter of an hour, half an hour, an hour, an hour and a half, and two hours respectively, and transparency-curves obtained by plotting the results on paper. These curves show that (1) the transparency of every specimen, with the exception of obsidian, increases during the first few minutes; (2) agate and alum, after increasing in transparency for some time, become more and more opaque; (3) obsidian continually diminishes in transparency. It is, of course, here a question of relative transparency with respect to tin. Although we have no measure of the variations of the absolute transparency of the tin itself, the experiments suffice to prove that the absolute transparencies of different substances vary according to the state of the tube, and it is therefore, not considered hazardous to explain these variations by the actinochroism of Röntgen rays.

The same phenomenon has been observed by MM. Benoist and Hurmuzescu and, perhaps, by other physicists. In some of Mr. A. A. C. Swinton's experiments it will be remembered that the properties of Röntgen rays, and particularly their power of penetrating through organic tissues, varied with the degree of exhaustion of the vacuum.

Two papers on Röntgen rays appear in a recent *Bulletin de l'Académie Royale de Belgique* (No. 5). One, on the probable cause of the production of Röntgen rays and of atmospheric electricity, and on the nature of electricity, is by P. de Heen. Judging from the analogy of a pith ball oscillating between two electrified plates, and from the comparative sizes of the pith ball and the air molecule, it may be assumed that the molecules have a velocity of 330,000 metres per second. This agrees fairly well with J. J. Thomson's estimate of a velocity of 200,000 m. per second for the kathodic projections. Such a velocity corresponds to the excessively high temperature of 46 million degrees. Hence, wherever these molecules impinge upon a surface, they will produce ether waves of very high frequency. These waves are probably identical with Röntgen rays, which are therefore very short ultra-violet waves. The author also claims to have proved that an electrified surface impresses a sensitive plate quite apart from any radiating action. He proposes the theory that positive and negative electricity are propagated in different ways, the former by transverse, the latter by longitudinal, waves. Atmospheric electricity is generated by masses of gas emerging from the interior of the sun (protuberances), which send out ultra-violet waves, and charge the atmosphere positively and the earth negatively by induction.

The reflection of Röntgen rays is treated by F. V. Dwelshauvers-Dery, in the *Bulletin* referred to in the foregoing paragraph. No trace of a regular or geometric reflection of Röntgen rays can be discovered. The wave-length of the rays is evidently too small in comparison with the size of the molecules. In order to find whether there was any diffuse reflection, the author placed a sensitive plate with the film downwards. A piece of ruby paper half covered the film, and sheets of zinc, brass, copper, tin, and collodion were placed under this. Then followed a second plate with the film upwards. On exposing the whole to Röntgen rays, both transmission and reflection could be studied. As regards the former, it was found that collodion increased the activity of the rays. This fact may be utilised to diminish the exposure, a sheet of collodion being placed above the object and the film. Impressions were also obtained on the upper plate, apparently due to diffused reflection. The order of reflective power was: tin, zinc, copper, brass, iron, platinum, gold, lead, aluminium. Hence tin placed below the film may also be used to diminish exposure. The state of polish of the surface was without influence, which shows that there was no regular reflection. But the most important fact is that the ruby paper intercepted a large proportion of the reflected rays. Hence the latter are not Röntgen rays proper, but rays of greater wave-length, and it may be maintained that X-rays are not reflected as such.

Herr W. Arnold (*Centralblatt für Nahrungs- und Genussmittel-Chemie sowie Hygiene*) shows that Röntgen rays can be employed with considerable success in the detection of food adulteration. Carbohydrates, fats, and aniline dyes were found to be very transparent to these rays, though slight differences were noticeable. Among the vegetable oils the order of transparency was: (1) castor oil, (2) almond oil, (3) olive oil of Provence, (4) poppy oil, (5) oil of sesame, (6) linseed oil; the difference between the last five was very slight, but castor oil was considerably more transparent. Of fats, butter was the least transparent, lard came next, and margarine was the most transparent; while the opacity of a mixture of different fats was found to vary with the percentages of its constituents. Among the spices, Herr Arnold found that the transparency decreased as the proportion of ash increased, so that saffron was the least and pepper the most absorbent of Röntgen rays. Foreign matter mixed with spices, such as brick-dust, ochre, sand, &c., was conspicuous, while adulterations of flour with powdered fluor or other spar, or chalk, could readily be detected. Earthenware glazes containing lead differed strongly from ordinary glazes, since, of all substances, lead offers the greatest resistance to the passage of Röntgen rays. For colouring matters imbedded in gelatine the order was: (1) methylene blue, (2) cyanin, (3) methyl violet, (4) eosin, (5) fuchsin, (6) brown, (7) orange, (8) chrysanilin, (9) fluoresin; the order must thus be blue, red, yellow, so that the lightest colours are the least transparent. In wines the transparency decreased as the proportion of sugar increased, just as generally the absorbing power of fluids increased with their specific gravity, and that of the elements with their atomic weight. In salts, the radical had considerable influence, and arseniates, sulphates, and phosphates exhibited a far greater power of absorbing the rays than chlorides.

The same writer also discusses the luminosity of solids under the influence of Röntgen rays. Referring to the use of fluor spar in shortening the time of exposure of radiographs, as employed by Winkelmann and others, Herr Arnold states in the *Apotheker-Zeitung* that he and Herr Forster-Bern have obtained negative results, as no difference was noticed between the action of the rays on plates exposed with and without the spar; possibly this was due to the quality of the spar employed. In the *Zeitschrift für Electro-chemie* he states the results of a long series of observations on various forms of luminosity, namely, thermo-luminosity, kathodo-luminosity, and what he proposes to call "X-luminosity." Herr Arnold finds tungstate of lime to

be the most luminous of all salts under the action of Rontgen rays, especially when in the form of the mineral known as tungsten. He thinks it exhibits the phenomena even in a more marked degree than platino-cyanide of barium. A solution of tungstate of copper in tungstate of calcium, moreover, glows with the same brightness as natural tungsten. A note on the best form of tungstate of calcium for showing fluorescence has also been published by Dr. Ferdinando Giazzi, of Perugia. By a certain process of heating in a coke furnace in the presence of oxygen, the tungstate is reduced to a white saccharoid mass which gives a much more brilliant glow than ordinary tungstate, but the effect can be further intensified by pulverising the mass and repeating the process, the final product which Dr. Giazzi calls the "bisaccharoid" form being, in his opinion, the best substance for shortening the exposure and intensifying the brilliancy of photographs taken with Röntgen rays.

Prof. Giuseppe Martinotti (*Rivista Scientifico-Industriale*) claims to have obtained shadow photographs of metal objects by the use of different kinds of light (including that of bisulphide of carbon), the light from a sulphur flame being found the best. Perhaps the radiations by which these results were obtained may be identical with Le Bon's *lumière noire*. This latter phenomenon deserves to be more fully investigated by physicists than has been done.

At a recent meeting of the *Société Française de Physique*, a discussion took place on a new arrangement of vacuum tube introduced by M. Colardeau, which gives, with short exposures, great clearness of images. The ordinary "focus" tubes are, according to M. Colardeau, open to several objections; amongst others, the thickness of the glass required to stand the external pressure arrests the passage of a large proportion of the rays; the energy of the discharge is not sufficiently concentrated round the kathode, and the distance between the kathode and anti-kathode is too great. The new form of tube is a cylinder of not more than 6 or 7 mm. diameter, containing a concave kathode of 4–5 mm. radius of curvature, which nearly fills the width of the tube. The lamina inclined at 45°, forming the anti-kathode, is only 7–8 mm. distant from the kathode, and just opposite the focus; and the glass of the tube is blown out into a hemispherical knob 1/10 mm. in thickness; the latter offers but little resistance to the passage of the rays generated at the focus. With this disposition stereoscopic radiographs were taken, which stand out in remarkable relief. The tube has stood the test of a discharge from a coil of very large dimensions without the least injury.

Finally, we would call attention to the excellent radiograph of an entire newly-born child taken by Prof. A. Imbert and M. H. Bertin-Sans, of the University of Montpellier, which is reproduced in the *Revue Générale des Sciences* for June 30. In sharpness of outline and general detail it far excels anything previously attempted in this direction.

METALLIC CARBIDES.

UNTIL about three years ago, the only definite compounds of carbon with metals whose existence had been proved with certainty were the acetylides of some of the metals of the alkalis and alkaline earths, and these were only known in an amorphous and impure state. The construction of the electric furnace by M. Moissan in 1893, in which the heating power of the electric arc was directly utilised, by extending the upper limit of working temperatures, added a powerful instrument of research to the laboratory. Among the many new fields of work thus opened up, the preparation of the difficultly reducible metals, such as tungsten, molybdenum, manganese and chromium, was attacked with much success by M. Moissan. These reductions being necessarily effected in the presence of carbon, the formation of definite metallic carbides of great stability soon became apparent, the properties of which proved to be of such interest that their preparation was systematically attempted. Certain metals, such as gold, bismuth, lead, and tin, do not form carbides at the temperature of the electric furnace, neither do they dissolve any carbon. The metals of the platinum group dissolve carbon with facility, but deposit the whole of it on cooling in the form of graphite, the metals being unchanged. Copper, silver and iron take up carbon in quantities that, although small, are sufficient to cause marked changes in the physical properties of the metals; it is noteworthy that no definite crystalline compound could be obtained with iron. On the other hand, fused aluminium takes up carbon readily with formation of the crystalline carbide Al_4C_3, and the oxides of many other metals furnish similar crystalline compounds when heated in the electric furnace with an excess of carbon. The behaviour of these substances with water furnishes the most convenient mode of classification. The carbides of molybdenum, Mo_2C, of tungsten, W_2C, of titanium, TiC, of zirconium, ZrC and ZrC_2, and of chromium, Cr_4C and Cr_3C_2, do not decompose water at the ordinary temperature. Of those reacting with water, the carbides of lithium, Li_2C_2, calcium, CaC_2, strontium, SrC_2, and barium, BaC_2, furnish pure acetylene; of aluminium, Al_4C_3, and of beryllium, Be_2C, pure methane; of manganese, Mn_3C, a mixture of equal volumes of hydrogen and methane; whilst the metals of the cerite group give crystalline carbides of the type RC_2 (CeC_2, LaC_2, YC_2, and ThC_2), all of which react with cold water, forming a complicated gas mixture containing hydrogen, acetylene, ethylene, and methane. But the most complex reaction is that furnished by uranium carbide, U_2C_3, with water. In this case, in addition to a gaseous mixture containing methane, ethylene, and hydrogen, liquid and solid hydrocarbons are produced in abundance, more than 100 grams of liquid hydrocarbons being obtained in one experiment from four kilograms of carbide. Cerium and lanthanum carbides have also furnished small quantities of solid and liquid hydrocarbons.

With the exception of chromium and zirconium, which form Cr_4C, and Cr_3C_2, ZrC_2, and ZrC respectively, only one carbide of each metal appears to exist, the formula of which is usually simple, and not always in accordance with what would be expected from the position of the metal in the periodic system. Thus, whilst the carbides of calcium, strontium, and barium have the formulæ CaC_2, SrC_2, and BaC_2, and yield pure acetylene upon treatment with water, beryllium forms Be_2C, from which pure methane is obtainable (Lebeau). As already mentioned, aluminium forms Al_4C_3 giving pure methane, whilst the higher members of the same group, yttrium and lanthanum, give YC_2 and LaC_2, yield, with water, complicated mixtures of acetylene, hydrogen, ethylene and methane, together with some liquid hydrocarbons. Cerium and zirconium, again, which are closely allied in the periodic system, form carbides having totally different properties, CeC_2 giving acetylene and methane with water, ZrC and ZrC_2 being unattacked under the same conditions.

These discoveries have already been applied technically in two directions—in the commercial production of acetylene from calcium carbide for enriching coal gas or for burning alone, and in the production of the carbides of silicon, CSi (discovered by Acheson), and of titanium CTi, both of which are extremely hard, the latter even cutting diamond. In organic chemistry, also, they afford a direct synthesis of many hydrocarbons, and offer a means of preparing pure methane and acetylene in large quantities. But perhaps their greatest interest lies in their bearing on certain geological problems. Starting with the fact that cast iron on solution in dilute acids gives a mixture of hydrocarbons, Bjasson and Mendelejeff twenty years ago suggested, independently, that the deposits of petroleum may be due to the infiltration of water into molten masses of metallic carbides, and this view was supported by an observation made about the same time by Silvestri, that some lavas of Etna contained petroleum.

In discussing this question in the light of his own observations, described before the Royal Society on June 18, M. Moissan protests against too hasty generalisation in this matter, as petroleums of different origins may exist, there being clear evidence in some cases that bituminous schists have been formed by the decomposition of organic matters. On the other hand, there is the continuous evolution of methane at Bulgonak and in Pennsylvania, which might well be formed by the action of water upon aluminium carbide; the presence of free hydrogen in the submerged volcanic vents at Santorin (Fouqué), and the occurrence of petroleum and carbonaceous products towards the end of a volcanic eruption, the violence of which would be fully accounted for by the supposition of the entry of water upon metallic carbides at a high temperature. There is also the possibility of explaining the occurrence of petroleums of different composition, for whereas a deposit of the carbides of the alkaline earths would yield acetylene, which at the extremely high temperature necessarily produced and in presence of free hydrogen might be expected to yield hydrocarbons of the Russian type, the carbides of aluminium and uranium, at perhaps a lower temperature, might account for petroleums of the American type. The whole work is extremely suggestive to vulcanologists, and will doubtless result in further investigation on the geological side.

G. N. H.

ITALIAN SCIENTIFIC EXPEDITION TO MONTE ROSA.

Referring to the letter published in Nature (No. 1307, November 19, 1894), we have been able this year to complete our researches on the waters of the Monte Rosa from the highest summit down to the glacial streams and lakes at about 2000 metres above the sea level.[1] Having carried up to our laboratory on the Lavez Alp (2450 m.) a good analytical balance, some quantitative determinations could be made on the spot. As might be anticipated, the amount of suspended matter in the water of the streams issuing immediately from the glaciers varies considerably not only on different days, but even in the same day. While on a cold, snowy day (August 3), the water of the Indren torrent contained 0·011 gr. (per litre) of sandy detritus, sixty times as much (0·66 gr.) was found on August 10, on an exceedingly warm, sunny day. On a regular summer day, with a mean temperature, the amount of suspended matter in the Indren waters varies from 0·010 gr. in the early morning to 0·09 gr. in the afternoon.

This matter is composed of two kinds of sand: one coarser, which sinks to the bottom in a few hours, and can be severed at once by filtering; and a subtler one, which remains permanently suspended in the waters, passes through the paper, and may only be determined by allowing the water to evaporate and extracting the residue with distilled water to dissolve the soluble salts. The ratio of the two kinds of suspended sand varies with the temperature; the finer one being very scarce, about 14·3 per cent. of the total amount on an average day, rising to 42·0 per cent. when the heat is very great, and when the melting of the ice proceeds with great intensity and speed. This seems to indicate a different origin of the two constituents; the coarse sand being perhaps spread over the surface of the ice fields, and the fine one being enclosed within the glacial masses.

In winter the melting of the glaciers is considerably reduced, and the waters of the Lys, which drain the valley of Gressoney, are nearly clear and transparent.

The amount of dissolved matter—the so-called fixed residue—in the different waters is shown in the following table.

	Milligr. per litre.
Loose, granular ice of the Punta Gnifetti (Signal Kuppe 4561 m.)	16·9
Compact ice of a crevasse at the foot of the Vincent Pyramid (3700 m.)	2·4
Compact ice near the Capanna Gnifetti (ab. 3600 m.)	13·9
,, ,, ,, ,, ,,	8·8
Surface ice of the Garstelet glacier (3300 m.)	1·6
Water of the Salzia lake (2670 m.)	27·2
Water of the Gabiet lake (2339 m.)	25·1
,, ,, ,, ,, ,, ...	23·1
,, ,, Sella spring (about 2250 m.)	30·8
,, ,, Indren torrent (about 2400 m.)	16·1
,, ,, ,, ,, (on a hot day)	21·2

The water obtained from the melting of the ice of the glaciers is the purest of all, in some instances nearly as pure as distilled water. It is very interesting to remark that the amount of dissolved salts in the samples taken in the same glacier, and even in the same spot, is never constant; this shows that the different snow and ice streams which descend from the buttresses of the mountain to form one great ice river, while compressed side by side with the others, still retain their own individuality, and are not confounded together in a uniform mass.

The residues of the waters consisted of sodium and calcium, together with sulphuric and hydrochloric acid; sulphate of lime was prevalent in the lakes and in the Sella spring, the latter showed also the presence of carbonates. Iron (dissolved) was found in traces here and there in the ice-waters. The suspended matter (sand) consisted of silicates with a large amount of iron.

As stated in my letter already referred to, the ice of Monte Rosa contains small quantities of ammonia; the maximum, of 0·3 milligr. per litre, was found in a block of ice at the foot of the great Glacier du Lys, about 2150 m. The waters of streams, lakes, and springs show no ammonia; only during a very hot day the waters of the Indren, which were turbid with an unusual amount of sand, contained a little ammonia, which disappeared in a few hours; the oxygenated compounds of nitrogen (nitrates and nitrites) were absent in every case.

[1] *Giornale della R. Accademia di Medicina di Torino*, anno lviii. fasc. 11, 32 pp.

Muntz and Aubin, as well as Boussingault, came to the same results from the analyses of the meteoric and telluric waters collected above or a little below 3000 metres. The absence of nitric and nitrous compounds in the waters of these heights is perhaps to be explained by the mean elevation of thunderstorms, which generally do not reach the 3000 metres in our zone, and to which the synthesis of those compounds from the elements of the atmosphere is mainly due. But many more accurate meteorological and chemical observations are necessary to confirm this hypothesis on a solid ground.

Among the interesting results of our expedition was the discovery of a substance having all the characters of the cryoconite as described by Nordenskiöld, who first discovered and named it. A fine, black, soot-like, light dust, lying at the bottom of lilipufian wells closely spread over the surface of the ice, was collected on the Garstelet glacier, and might perhaps be found on every flat ice-field whose surface is free from the impetuous little rivulets which wash and carry away everything that come in their way.

An immediate analysis of the cryoconite could not be made; I sealed the dust up on the spot in little glass bottles, which were opened later in my laboratory in Turin, when I found that putrefactive processes had taken place; gases, traces of skatol (or indol) together with a fatty (butyric?) acid had been formed, and the iron—which might have been originally in a metallic condition was dissolved as ferrous salt, showing the want of oxygen in the air of the bottle.

The presence of organic living matter in the cryoconite is confirmed by the results of an examination of the cryoconite made by Dr. Belli, of the Botanic Institute: he found in the cryoconite:—

Algæ: (Diatomaceæ). *Pinnularia* sp., *Navicula* sp., *Frustulia* sp. (?)
(Cyanophyceæ) *Oscillaria*, sp.
(Chlorophyceæ) *Pleurococcus* sp., *Chroococcus* sp., *Hematococcus pluvialis*, Kh.
Fungi (Bacteriaceæ) *Bacillus* sp., *Bacterium* sp.
,, (Ascomycetes) spores with echinated episporium, difficult to be determined.
Gymnospermæ—Pollen of Coniferæ (Abietineæ?)

Besides pappi of Compositæ (?) or of Graminaceæ or Cyperaceæ, threads or trychoms belonging to feathery seeds (*Salix*, *Epilobium*, *Clematis* (?).

Of the cryoconite 16 per cent. is organic matter, 3·5 per cent. iron, and the remnant detritus of different minerals.

A study of the distribution of micro-organisms in the ice and waters of Monte Rosa has also been made, and will be shortly published. Piero Giacosa.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Mr. F. W. Burstall, Demonstrator of Mechanical Engineering at King's College, London, has been appointed Professor of Civil and Mechanical Engineering at Mason College, Birmingham.

The London University Commission Bill, which would have passed through the House of Commons this session if all parties had been willing to permit it, has been withdrawn, the Church party having claimed the insertion of a clause embodying a fragment of the Tests Act.

The action of the North Riding of Yorkshire in adding millinery to the list of technical subjects aided by the funds at their disposal, can hardly be commended. It was not for the purpose of teaching such empirical arts as this, that the Technical Instruction Acts were passed.

There does not seem to be a great demand for instruction in technical subjects in Cambridgeshire. At the recent meeting of the County Council a comparative failure of the lectures in agriculture had to be reported, and, following this, one member of the Technical Instruction Committee was understood to say that he supposed the money must be got rid of, but that he did not think it would do sixpennyworth of good! There yet remains much for the advocates of the teaching of natural science to do.

Among recent announcements we notice the following:—Dr. Schleiermacher to be Professor of Electro-technics in the Technical High School at Karlsruhe; Dr. Schuberg to be Extraordinary Professor of Zoology in Heidelberg University; Dr.

A. C. Abbott to succeed Dr. Billings in the chair of Hygiene in the University of Pennsylvania; Dr. Franz Hofmeister to succeed the late Prof. Hoppe-Seyler as Professor of Physiological Chemistry in Strassburg University; Prof. P. Jacobsohn to be General Secretary of the German Chemical Society; Drs. Josse and Kämmerer to be Professors of Engineering in the Technical High School of Berlin; Prof. Schmidt, of Stuttgart, to be Director of the Weather Bureau at Wurtemburg.

The Technical Education Committee, in their report to the recent meeting of the Nottinghamshire County Council, called attention to rather an unlooked-for difficulty which had presented itself in connection with their Dairy Institute. It appears that the butter made there is in such request that they had a demand for 1000 lbs. per week, and were actually producing as much as 500 lbs. in this period. The temptation is to convert the institute into a butter-factory, and so into a money-making concern; but the Council supported the Committee in their recommendation that it would be altogether inadvisable to sacrifice the educational interests of the institution to such pecuniary considerations, and that, as in the past, the first aim of the staff must be the instruction of the students.

It may be thought that the experimental stage in the administration of the Customs and Excise grants to education has been passed, but recent reports seem to negative this idea. The Lancashire committee report that they have been able to allot only eight out of ten science scholarships, the candidates showing a greater preference for the study of art. The Organising Secretary for the Lindsey division of Lincolnshire tells of 868 candidates for technical examinations this year as compared with 1012 last year. We hope that this does not mean that the novelty is wearing off, and that the serious demand for instruction of this kind is really less than had been anticipated. However this may be, there can be no doubt of the wisdom of the grant of £150 by this Council to the Nottingham University College for the year 1896-7.

At the recent general meeting of the Association of Directors and Organising Secretaries for Technical and Secondary Education the following resolutions were adopted: (1) "That, in the opinion of this Association, it is desirable to ask the Government to receive a deputation to urge upon them the importance of bringing in a Bill early next session dealing with the subject of Secondary Education." (2) "That it is inexpedient to give grants to any non-county borough for building or equipment except upon the terms that such grants shall be returned in the event of such borough becoming a separate educational authority." (3) "That this Association protests against the action of the Science and Art Department in making changes in its grants and regulations for the conduct of its classes without giving due notice to or consulting the local authorities who are so vitally interested in the efficiency of these classes, and particularly urges that the regulations contained in Form 306 be postponed until the issue of the Directory for 1897-98."

The Organising Secretary for Technical Instruction in the county of Shropshire, in reporting a diminution in the amount of work done in different parts of the county during the past session, observed that it "is ascribable to the vote of the Council in May 1894, by which the fund for technical instruction was reduced to the extent of £3000." This lessening of the grant has been more particularly felt in the towns where the best work was being done by science and art committees. The interruption of a systematic course of training is not, he finds, so serious in rural districts. The diminution complained of is the more to be deplored since already it has been found that the work of the Committee has been productive of practical results, particularly in the ornamental iron and tile manufactories and in the china works of the county. We notice that this Council has provided for the training at suitable institutions of six women as certificated midwives, and that the women have been selected with the view to their being able to follow the calling in parts of the county where there is most need for the services of such skilled nurses.

The County Committees in charge of technical instruction will do well to take notice of the letter received from the Science and Art Department by the Clerk of the Cornwall County Council, which decides a point of some interest. The letter, which is in reply to a query from the Clerk, runs as follows:—"I am directed to acquaint you that the Department, having already consulted the Local Government Board on the question of the provision of prizes by local authorities, is of opinion that the Cornwall County Council cannot properly apply funds placed at their disposal for the purposes of technical education to awarding prizes (through the medium of local committees) at competitions in agricultural processes to persons other than those who have been taught in classes under the control of, or aided by, the County Council." This decision will prove very salutary, we should think, in view of some of the claims which have been made; for instance, from some districts payments for luncheons, refreshments, ale, spirits, &c., have been demanded—things we should have thought nobody would have supposed connected with technical education.

SCIENTIFIC SERIAL.

Ciel et Terre of July 16 contains an article by M. A. Lancaster, of the Royal Observatory of Brussels, on the intensity of tropical rainfall. There are many points in that zone where the yearly rainfall exceeds 120 inches; such amounts clearly indicate more or less continuous falls of great intensity. The author quotes various excessive amounts observed in periods of twenty-four hours and less, but we extract only a few of the principal falls, reduced to a period of one minute and expressed in inches:—Hong Kong, ·047; Buitenzorg, ·049; Newcastle (New South Wales), ·071; Lahore, ·095; Brussels, ·114; London (Camden Square), ·167. These figures show that the falls of rain in the tropics are not more intense than the extraordinary falls in our own parts, but the former generally exceed the latter in duration; hence the much greater absolute quantity recorded in equatorial regions.

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, August 3.—M. A. Chatin in the chair.—Study of the diamond-bearing sands of Brazil, by M. H. Moissan. From 4·5 kilos. of sand, only 2 gr. of material free from silica was obtained, and this was found to contain a small quantity of gold, platinum and graphite, together with a minute amount of diamond, partly black and partly transparent.—On the oxidation of the organic material of the soil, by MM. P. P. Dehérain and E. Demoussy. At temperatures slightly above 100° the organic material of soil is rapidly burnt by the oxygen of the air. This oxidation still goes on, without any organisms being present, at 40° to 60° C., and hence in hot climates the soil would become sterile from this cause.—On a hybrid from *Ovis tragelaphus*, by M. A. Milne-Edwards.—An extension of the application of the law of equivalence of energy in biology, by M. A. Chauveau.—Remarks on a note of M. A. Lœwy on definite quadratic forms, by M. L. Fuchs. The theorem in question is a special case of a theorem given in a memoir published in the *Sitzungsberichte* of the Berlin Academy.—The conditions under which the deposits of phosphate of lime have taken place in Picardy, by M. Gosselet. It is regarded as established that these phosphatic deposits were formed at very slight depths.—On the integration of simultaneous partial differential equations, by M. E. von Weber.—On a class of isothermal surfaces depending on two arbitrary functions, by M. A. Thybaut.—On the error of refraction in geometric levelling, by M. Ch. Lallemand. The formulæ given in a preceding paper are for practical purposes given in a graphical form.—On the non-refractibility of the X-rays by potassium, by M. F. Beaulard. A prism of potassium gave no appreciable deviation of Röntgen rays, the index of refraction differing from unity by a quantity less than 1/10,000.—Nitrogen and argon in fire-damp and in gas from Rochebelle, by M. Th. Schlœsing, jun. The gas left after removal of methane and carbon dioxide, consisting of argon and nitrogen, on absorbing the latter gave amounts of argon varying from 1·09 per cent. to 3·27 per cent. of the mixture. These figures show that this argon does not come directly from the air, but it is still possible that it may have come indirectly by solution in water, in which argon is the more soluble.—On the specific heat of sulphur in the viscous state, by M. J. Dussy. The specific heat of viscous sulphur is distinctly higher in the viscous than in the liquid state. If the total quantity of heat lost by 1 gr. of sulphur in passing from a temperature T to 0° C. is plotted against the temperature, there is a distinct change of curvature at about 230° C.—Contributions

to the analytical characters of the compounds of tungsten, by M. E. Defacoz. The tungsten compound is converted into a tungstate, heated with some $KHSO_4$ and a little sulphuric acid, and a drop of this, added to such reagents as phenol, naphthol, morphine, &c., when characteristic colour reactions occur. Of these the red coloration with phenol, and the violet with hydroquinol, are the most sensitive and distinctive.—On the action of aluminium chloride upon benzene containing thiophene, by M. Eyvind Boedtker. Hydrogen sulphide is evolved, and the bulk of the thiophene is destroyed.—On some new mixed trimethylene compounds, by M. L. Henry. The new substances described are α-iodo-ω-chloro-propane, $CH_2Cl.CH_2.CH_2I$; and the corresponding nitro-derivative, $CH_2Cl—CH_2.CH_2.(NO_2)$.—The rapid estimation of the constituents of a mixture of primary, secondary, and tertiary amines, having the same fatty alkyl group, by M. Ch. Gassmann. The mixture is titrated with hydrochloric acid, and then with sodium nitrite in acid solution; the solution of the resulting simultaneous equations gives results of sufficient accuracy for industrial purposes.—On the compounds oxidisable under the influence of the oxidising ferment of mushrooms, by M. Em. Bourquelot.—On the hybernation of the *Clavelina lepadiformis* (Müller), by MM. A. Giard and M. Caullery.—Treatment of experimental infections by intravenous injection of a solution of common salt (0·7 per cent.), and their mode of action, by MM. F. J. Bosc and V. Vedel.—On the nature of the "Chabins," by M. Ch. Cornevin. The Chabin (so-called by Gay) of Chili is not a hybrid, but a species of sheep.—Chemical study of low-class flour used in baking, by M. Balland.—On the proximate composition of the gluten of cereals, by M. E. Fleurent.

AMSTERDAM.

Royal Academy of Sciences, June 27.—Prof. van de Sande Bakhuyzen in the chair.—Mr. C. Eykman presented for publication in the Academy's *Transactions* a paper on the respiratory gas interchange of the inhabitants of the tropics. The principal result of the experiments made at Batavia with Geppert and Zuntz's apparatus, on persons in a state of rest was, that both the European and the Malayan inhabitant of the tropics, the weight of their bodies being reduced to the same standard, use the same quantity of oxygen, and consequently produce the same amount of heat, as the inhabitant of the temperate zones, to whom the same test has been applied. Moreover, the ratio of the quantity of carbonic acid exhaled to that of oxygen inhaled by Europeans, is pretty much the same in India as in Europe; with Malayans the amount of carbonic acid exhaled is comparatively a little greater, which is accounted for by the food of the latter being richer in carbohydrates.—Prof. van Bemmelen communicated the result of an investigation into the proportion of fluorine in the fossil bones from the Pliocene formation in Middle-Java (Dubois' collection), which proportion was determined by the author in co-operation with Mr. Klobbie. He also treated of the coefficient of distribution in the absorption of dissolved substances by colloids.—Prof. van de Sande Bakhuyzen dealt with the determination of the error of projection in the case of Repsold's instrument for measuring photographs of stars.—Prof. Kamerlingh Onnes presented a continuation of his observations on the measurement of low temperatures.—Mr. Verschaffelt described measurements of capillary ascents of liquid carbon near the critical temperature. In his thermodynamic theory of capillarity, Prof. van der Waals has calculated, on theoretical grounds, the surface energy of a liquid near the critical temperature. He arrives at the conclusion that, at least if the temperature is very nearly critical, it must be possible to represent the surface energy by the formula, $\sigma = A(1-m)^{3/2}$, in which A is a constant, and m the reduced temperature. The values of σ, deduced from experiments made by de Vries, and by Ramsay and Shields, may now be represented by a formula $\sigma = A(1-m)^B$, in which B is generally constant and smaller than 3/2, though in a few cases it gradually increases, in proportion as the critical point is approached. It was, therefore, desirable to measure some ascents, when the temperature was still nearer the critical point; and liquid carbonic acid was selected for this investigation. Up to 30° the change of the height of ascent is pretty nearly linear; for a capillary of a radius $r = 0{\cdot}0441\ m$M, it was found that

$$HmM = 26{\cdot}04 - 0{\cdot}825\ t.$$

As this line cuts the temperature axis at 31°·6, and as the critical point, where H must be = 0, was found to be 31°·0, the "height-of-ascent" curve must incline a little towards the temperature axis between 30° and 31°, which was actually observed. For the calculation of the surface energy the liquid and gas densities determined by Amagat were used. Cailletet and Mathias have constructed parabolic formulæ for those densities, from which follows, it would seem, $\int v - \int d = k\sqrt{1-m}$. According to van der Waals this relation must be theoretically satisfied, at least near the critical temperature. When the quotient

$$\Delta \log \left(\int v - \int d\right) / \Delta \log (1-m)$$

is now deduced from the densities, given by Amagat, then it appears that up to about 30° it remains pretty nearly constant, the mean being 0·367, consequently smaller than the value derived from Cailletet's and Mathias's formulæ; above 30° it rises and reaches the value 0·521, in accordance with the theory. As regards $\Delta \log \sigma / \Delta \log (1-m)$, which, according to van der Waals, must become equal to 1·5 in the immediate proximity of the critical temperature, the calculation shows that this quotient becomes smaller up to 29°, but then it increases again, the maximum found being 1·512.—Prof. Engelmann communicated the result of investigations into the origin of the normal movement of the heart, from which it appears that very probably it is not of a neurogenic, but of a purely myogenic nature.—Prof. Franchimont presented, on behalf of Dr. P. van Romburgh, of Buitenzorg, a paper on the action of iodine upon potassium cyanide, and of iodine cyanide upon caustic potash, in which it is proved that the opinion that iodine cyanide behaves differently from potassium, from bromine- and chlorine-cyanide, is founded on an error, which has probably originated in not awaiting the end of the reaction, on making the experiments. After twenty-five minutes the final products are: at 25°, potassium isocyanate and potassium iodide; they are also obtained by adding iodine to an alkaline potassium cyanide solution, when for a moment the smell of iodine cyanide is observed. The concentration seems not to have any influence upon the result, but it has upon the rapidity of the reaction.

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THURSDAY, AUGUST 20, 1896.

A SYSTEM OF MEDICINE.

A System of Medicine. By many Writers. Edited by Thos. Clifford Allbutt, M.A., M.D., F.R.S., Regius Professor of Physic in the University of Cambridge, &c. Vol. i. Demy 8vo, pp. 1008, 38 illustrations, 13 charts, 1 coloured plate. (London: Macmillan and Co., Ltd., 1896.)

IT is almost exactly thirty years ago since the first volume of the "System of Medicine," edited by Sir Russell Reynolds, was published; and the dedication of the present work to him is a touching acknowledgment, on the part of the editor, of the service rendered to medicine by the late lamented President of the College of Physicians, and his band of collaborators. Thirty years has produced not only great changes in medicine itself, but also great changes in the methods of attacking medical problems. The intimate relation in which medicine to-day stands to what may, perhaps, collectively best be termed experimental pathology, has rendered necessary in the present System, the collaboration of a band of authors whose names are better known as physiologists, pathologists, or bacteriologists than physicians, and their contributions lend a very special value to the work. The book begins with an academic introduction by the editor, who at once rightly denies any corporeal fixity to the term "System of Medicine," and defines it as "a setting forth of the whole of our knowledge, as immediate convenience and the exigencies of contemporary learning may dictate." A few brief but pregnant remarks upon classification, nomenclature, diagnosis and prognosis, lead us to Division i. of the System, which has received the name of prolegomena. Each of the articles, twenty in number, contained in this part of the work is complete in itself, and may be regarded as representing the present state of our knowledge upon the subject of which it treats.

Medical Statistics are dealt with by Dr. Billings in a most able and exhaustive manner; Anthropology and Medicine by Dr. Beddoe. Dr. Rivers, in a short essay on Temperament, points out that a valuable classification of temperaments may be expected from a study of this subject on the lines of Galton and Kraepelin. Mr. Hutchinson, in a few pages, discusses "The Laws of Inheritance in Disease." Dr. Haviland tells us succinctly what is known with regard to the relations of the physical geography of this country to heart disease, cancer and phthisis.

One of the most difficult tasks in the book has fallen to the lot of Prof. Adami, who contributes the monograph on Inflammation. The article is divided into three parts. Part i. is devoted to the comparative pathology of inflammation; chapter i. is introductory; chapter ii. contains an account of the researches of Metschnikoff, Krukenberg, Reinke, and others, on the effects of irritants on the protozoa and lower metazoa; chapter iii. describes the main forms of the process of acute inflammation in the higher animals, in which the experimental production of suppurative inflammation finds a place. Here the author considers at length the work of Cohnheim, Grawitz, and De Barry, Councilman, and others. Part ii. is devoted to the factors in the inflammatory process considered in detail, and first and foremost the part played by the leucocytes. The author here gives, with a table, a classification of leucocytes according to the different authorities. The rival theories of "phagocytosis" and "extra cellular action" are discussed at length. Dr. Adami inclines to the view that although different bacterial products may give rise to positive chemiotaxis of varying intensity, the possession by these products of actual negative chemiotactic properties is very doubtful. The author concludes by saying that however important phagocytosis may be to the organism, the extra-cellular action of active and disintegrating leucocytes may under certain conditions be even more so. The question of the inflammatory exudation, the part played by the vascular and nervous systems, the diapedesis of the leucocytes, which the author regards as active, and caused by the positive chemiotactic properties of the irritant, are each considered. Of the *rôle* played by the cells of the tissues, and of the origin of the "fibroblasts," a full account is given; and this part of the subject concludes with an exhaustive chapter on the varieties of fibrous hyperplasia and their relation to inflammation. Part iii. is devoted to classification and the systemic changes consequent upon inflammation. The author, in conclusion, defines inflammation as "the local attempt at repair of actual or referred injury." In the article just considered, Prof. Adami has certainly accomplished the task he set before himself, viz. "to bring into order the very numerous recent researches upon the inflammatory process, and to show whither they appear to tend."

The Doctrine of Fever is dealt with by Dr. Burdon Sanderson, and divided into two parts. Part i. is a historical retrospect which deals chiefly with the views of Cohnheim, Senator, Traube, Pfluger, and Leyden. Part ii. gives an account of the researches bearing on this subject since 1883. The relation between the increased proteid disintegration in fever and in inanition is discussed, as is the production of "fever," so called, by cerebral puncture and the mode of action of antipyrine and other antipyritics.

An article on the General Pathology of Nutrition is contributed by Dr. F. W. Mott. Dr. Mott first describes the physiology of nutrition, and discusses the influence of the quality of the blood, the internal secretions of the organs, the nervous system, and the inherited specific properties of the blood, upon the maintenance of a normal state of nutrition. Necrosis, atrophy and fibrosis, the degenerations, and hypertrophy are fully dealt with. The author holds the view that in the fatty degeneration of myelin, lecithin is the source of the fat, and suggests that extensive degeneration of this kind may produce an auto-intoxication. The article is well illustrated. A monograph on the General Pathology of New Growths is communicated by Messrs. Shattock and Ballance. The chief interest of this article lies in the full description and searching criticism of the parasitic theory of carcinoma. The authors have spared neither time nor trouble to put this theory to scientific tests. All attempts to cultivate the hypothetical parasite of carcinoma, either directly in various media or through the intervention of lower forms of life, were negative. The treatment of

carcinoma and sarcoma by injection of a glycerine extract (50 per cent.) of the respective growth, was also without result, as was also treatment with Fehleisen's fluid.

The Principles of Drug Therapeutics are considered by Prof. Leech. Dr. Herman Weber, assisted by Dr. M. G. Forster, writes upon Climatology. The article comprises a consideration of some of the principal elements of climate, the chief climatic regions and health resorts, and the use of climate in the treatment and prevention of disease. The essay on Balneology and Hydrotherapeutics is from the same author, and is divided into two parts: (A) balneo-therapeutics, or treatment by the internal or external use of mineral waters; under this section the chief mineral waters are described, and their therapeutic use indicated. The second (or B) section is termed hydrotherapeutics: by this is meant the therapeutic use of water considered especially in its external application to the body; in this section the author is assisted by Dr. Parkes Weber. Artificial Ærotherapeutics is treated by Dr. Theodore Williams, the varieties of qualitative and quantitative differences in the constituents of the atmosphere are described, as are also the effects of atmospheres of varying barometric pressure. Dr. Lewis Jones writes upon the Medical Applications of Electricity. The units of measurement are explained, and the apparatus necessary for the application of electricity described. Six excellent diagrams of the motor points in the different parts of the body are given. The diagnostic use of electricity is fully discussed. The article closes with a consideration of the conditions in which the medical application of electricity has been of therapeutic value. Dr. Mitchell considers the technique, physiology and therapeutic uses of Massage. Under the head of physiology a *résumé* is given of the work of Lombard, Brunton and Tunnicliffe, Winternitz, and others. The varieties of massage, the duration and frequency of its application, are described, and the diseases in which massage has been useful enumerated. The Feeding of the Sick is the subject of an article by Sir Dyce Duckworth. The general principles of invalid dietetics are first clearly enunciated, and then all the experience of the clinician is brought to bear upon the subject of the diets suitable to various diseases. A most valuable addition to this subject comes from the pen of Dr. Eustace Smith, who writes upon the Diet and Therapeutics of Children. The very special way in which children react to different diets and forms of treatment, baths, drugs, &c., is described, and the way to obtain a maximum benefit from the remedies prescribed is clearly indicated. The editor has wisely included an article on Nursing, which is written by Miss Amy Hughes. The Hygiene of Youth is treated by Dr. Clement Dukes, in a paper which it would be well to place in the hands of every schoolmaster. The medical aspect of Life Assurance is considered by Dr. Symes Thompson. With this article Division i. of the work closes.

Division ii. is devoted to the consideration of the Fevers, and includes two parts. Part i. consists of an article from the pen of Sir Joseph Fayrer, on Insolation or Sunstroke. The Infections form the contents of Part ii. The subject is introduced by an article on the general pathology of infection, by Dr. Kanthack. The Infections are then divided as follows: (1) diseases of more or less established bacteriology, (2) diseases of uncertain bacteriology, (3) infective diseases communicable from animals to man, (4) diseases due to the protozoa. The first group is divided into local or general diseases due to pyococci, and the infective fevers, with which the volume ends.

Dr. Kanthack, in his article on the general pathology of infection, first considers the morphology of micro organisms and the conditions necessary for their existence; he then passes on to the products of bacterial activity. Ferments and enzymes, the ptomaines, toxalbumins, and the products of fermentation are fully discussed. The question whether the toxines are the result of the action of the bacilli on the tissues (Martin), or whether they are a true excretion or secretion of the bacilli themselves, is discussed, as are also the views of Klein on extracellular and intracellular poisons. A consideration of infection, contagion, and predisposition follows. The author then proceeds to the subject of natural and acquired immunity, and the article concludes with the history, principles, methods, and scope of serum therapeutics. Two admirable monographs on septicæmia and pyæmia, and erysipelas, are written by Mr. Watson Cheyne. The ætiology and general pathology of ulcerative endocarditis is dealt with by Dr. Dreschfeld; Puerperal Septic Disease by Dr. Playfair. The articles on boils and carbuncles are written by Dr. Melsome, that on Epidemic Pneumonia by Dr. Whitelegge. Epidemic cerebro-spinal Meningitis is considered by Dr. Ormerod, who adds an appendix describing the outbreaks of the disease in this country since 1807. Dr. Goodhart writes upon influenza. The article includes a description of Pfeiffer's bacillus, and the methods for its identification and cultivation. The article on Diphtheria is divided into four parts. The clinical aspects of Diphtheria are dealt with by Dr. Gee, its ætiology and prophylaxis by Dr. Thorne Thorne, its bacteriology and pathology by Dr. Kanthack, while Dr. Herringham gives the results of the serum treatment. The subject of Tetanus is also divided between two authors—Sir G. Humphrey contributing the clinical part, Dr. Sims Woodhead the pathological. The relatively unfavourable results of the antitoxine treatment in this disease, as compared with those in Diphtheria, are explained by Dr. Woodhead as being due to the fact that the treatment in tetanus is not begun until the effects of the poison on the general system (central nervous system), as distinct from its local effects, have manifested themselves; whereas in Diphtheria, the antitoxine is injected at a period at which the disease is practically a local one. Enteric Fever is treated in an exhaustive manner by Dr. Dreschfeld. The article contains a description of Eberth's bacillus, with the characteristics distinguishing it from the *B. coli communis*, and the methods for its detection. Extensive mortality tables form an appendix. Five authors are responsible for the article on Asiatic Cholera. Mr. Ernest Hart and Dr. Smith deal with the origin and mode of propagation of the disease, Drs. Kanthack and Stephens with the bacteriology, and Dr. Kenneth Macleod with the clinical, pathological, and therapeutical aspects of the subject.

The Plague is treated by Dr. Payne. The bacteriology of the disease, in the light of Yersin and Kitasato's researches, is fully discussed, and the possibility of treatment by antitoxine (Calmette). Relapsing Fever is dealt with by Dr. Rabagliati; the bacteriology of the subject being from the pen of Dr. Westbrook. With this last article Volume i. closes. At the end of each monograph there is a list of references, which are paragraphed, according to the sub-section of the article to which they refer. An accurate and extensive index of authors and subjects greatly facilitates the use of the book.

An idea of the labour requisite to the successful editing of a work like the one before us can only be formed by the experienced few who have accomplished it. To Prof. Allbutt are due the thanks and congratulations of cosmopolitan Medicine for having produced a work which in fulness, accuracy and interest, leaves nothing to be desired. F. W. T.

A TEXT-BOOK OF EXPERIMENTAL PHYSICS.

Lehrbuch der Experimental Physik. Von Eduard Riecke. Erster Band. Mechanik, Akustik, Optik. Pp. xvi + 418. (Leipzig: Verlag von Veit and Co., 1896.)

THE author, who is Professor of Physics in the University of Göttingen, is well and favourably known for his work in several departments of physical science, and the text-book he has written possesses the qualities we should expect to find in the work of one who is actively engaged not only in teaching physics, but in advancing the subject by research.

After an introduction on physical phenomena, physical hypotheses and theories, and elementary measurements such as those of angle, length, mass, and time, the treatise enters on the subjects of mechanics and acoustics, to which the first part of the present volume is devoted. This occupies pp. 20–261, leaving pp. 262–418 for the discussion of optics.

In opening his dynamical treatment, the author does not attempt to deal with the vexed questions of the foundations of dynamics, a procedure which is perhaps the best in the interests of beginners. The thoughtful student will be confronted with the fundamental difficulties soon enough, and according to his own ability and the skill of his dynamical adviser will be his relief from the serious mental embarrassment which he will inevitably experience. The thoughtless student need not be considered.

The author postpones the consideration of mass, and defines the unit of weight as the weight of a cubic centimetre of distilled water at maximum density under atmospheric pressure, which he calls a *gramme-gewicht.* We differ from the author as to this being the *definition* of the unit of weight in the metric system. Surely that unit is the weight of the standard kilogramme itself, or of $\frac{1}{1000}$ part of it. By the statement given the unit of weight is not immediately connected with the standard piece of matter; though it is no doubt very nearly $\frac{1}{1000}$ of the weight of the standard kilogramme. The unit of weight is, however, made the weight of a unit of mass, and is therefore, strictly speaking, a variable unit; it is used throughout the treatment of the statics of rigid bodies, with which the dynamical portion of the book begins.

The method adopted thus differs from that now usually followed, in English books at least, by considering a vertical string or bar which supports a body as stretched by a force equal to the weight of the body, as measured by the number of cubic centimetres of distilled water at maximum density which will just equilibrate the body in an accurate balance. Thus, so far as statics is concerned, a preliminary kinetic definition and discussion of force and the laws of motion are dispensed with.

Whatever opinion may be held as to the merits or demerits of this mode of presenting the subject of statics, there can be no question of the importance of referring the student on every possible occasion for illustration of principles and theorems to the great practical applications of dynamics that we have in abundance in engineering structures, and of the use where possible of graphical methods. This is an aim which the author keeps well in view, though in order to proceed to the consideration of stretching force and thrust, and ties and struts, it does seem a little hasty to dismiss the parallelogram of forces with a mere experimental proof by means of strings and weights.

The discussion of the kinetics (*dynamics* the author calls it) of solid bodies follows. This has many points of excellence. But we must rather demur to the comparison of the absolute and technical units, given at p. 67. Thus it is stated—

Absolute.	*Technical.*
Unit of mass equal to the mass of a gramme.	Unit of force equal to the weight of a gramme at latitude 45°.
Unit of force equal to the weight of $\frac{1}{981}$ gramme at latitude 45°.	Unit of mass equal to the mass of 981 gramme weights.

Whatever the somewhat disputed relative merits for different purposes of the absolute and technical system of units may be, it is universally admitted that the absolute C.G.S. unit of force is that force which gives a mass of one gramme an acceleration of 1 centimetre per second per second. To define it, or state its value as above, is to give no doubt a constant unit of force (on the supposition that gravity is constant at latitude 45°), but one differing perceptibly from that usually defined as the absolute unit, since the value of g at latitude 45° at mean sea-level is approximately 980·61 in centimetre second units. The great beauty of the absolute system as given by Gauss, surely lies in the fact that the fundamental units of length, mass, and time do all for us, and we have, so far as the *definition* of dynamical units is concerned, nothing whatever to do with gravity.

The proper definition of the unit of force it must be stated, however, is given *below* this "Gegenüberstellung" of units, so that the author probably does not offer the statement in the table as other than a comparison of values of units; but it is well to give first the definition, and rub it in with plenty of illustration. Only after the student has become perfectly familiar with the system of

units he has been introduced to, is it safe to bring another under his notice.

Many interesting cases of motion are well expounded and illustrated by diagrams, for example the motion of a pendulum with a gyrostat in its bob (a case of great importance in other branches of physics), and the precession of the equinoxes.

The statics and kinetics of fluids are next dealt with, and, as was to be expected, fluid motion is well attended to. Wave motion of a fluid and the principle of Huyghens are here discussed and well illustrated graphically. Then follows a wonderfully complete account, for the space devoted to it, of molecular phenomena of solids and fluids, including a sketch of the kinetic theory of gases.

The second half of the book, which deals with acoustics and optics, we have not space to speak of in any detail. Throughout we have clear description of phenomena, of apparatus, and of experimental processes, always with neat and truthfully-drawn diagrams. There is necessarily very little in the way of mathematical exposition of these subjects, but the results of mathematical and experimental investigation are clearly stated, and the book cannot but form an exceedingly useful introduction to an extended course of physical study, such as that for which one of the more elaborate Lehrbücher, which have lately appeared in Germany, might form a basis. It is very clearly printed, and, what is a great thing in a text-book, the numerous cuts have been very well engraved and printed.

A. Gray.

TRAVELS AMONG THE HAUSA.

Hausaland, or Fifteen Hundred Miles through the Central Soudan. By Charles Henry Robinson, M.A. Pp. 304. Map and illustrations. (London: Sampson Low, Marston, and Co., 1896.)

Mr. J. A. Robinson, the brother of the author of the book before us, died at Lokoja on the Niger in 1891, while engaged in the study of the Hausa language, and in his memory the Hausa Association was formed in the same year with a view to carry on the work. Mr. C. H. Robinson was selected by the Association as their first "Hausa Student," and he left England at the end of April 1893, to make acquaintance with the language, and also to learn Arabic. Instead of proceeding directly to the land of the Hausas, the climate of which at the best is very trying for Europeans, he went successively to Tripoli and Tunis, where he had opportunities of conversing with many of the Hausa pilgrims on their way from the interior of the Sudan to Mecca, and with any number of Hausa slaves.

Equipped by preliminary training in the language, and accompanied by two friends, Dr. T. J. Tonkin and Mr. John Bonner, Mr. Robinson reached Lokoja, at the confluence of the Niger and Benue, in August 1894; and, after wearisome delays in obtaining carriers, set out for Kano, the commercial capital of the Hausa states. They travelled up the Benue to Loko, then struck northwards by land through Kaffa and Zaria, and reached Kano on December 23. Here the party stayed for rather more than three months, engaged in diligent study, and then returned to the Niger and to Europe.

Hausaland is not a defined geographical area, but a group of native states occupying the fertile region of the Western Sudan between the territory of the Royal Niger Company (to which they are tributary) and the Sahara desert. Sokoto is the predominant state, but the chief town of the Hausas is Kano, a trade-centre of such importance that Mr. Robinson does not hesitate to dub it the "Manchester of the Soudan." The town is described in some detail, and this description is perhaps the most important feature of the book, which in other parts suffers from "padding," including long extracts from various writers on non-essential subjects. Kano is estimated to contain about 100,000 inhabitants; it manufactures much cloth, which is largely exported, and may be purchased in Alexandria, Tunis, or Lagos, so widely are its qualities appreciated. The markets also contain European goods, which are still, for the most part, brought across the Sahara from Mediterranean ports. The Hausas are born traders, and having acquired Mohammedan education, are by no means to be viewed as savages. They are, however, inveterate slave-traders; and Mr. Robinson is of opinion that this trade cannot be seriously combated until a satisfactory currency and mechanical means of transport are introduced. At present slaves are the larger, and cowries the smaller, units of value; and as a slave is worth several hundred thousand cowries, the carriage of his value in these shells would tax the resources of any caravan. There is one coin which passes current through the whole of Northern Africa—perhaps the last in Europe which would occur to any one set to guess its nationality and date—the silver Austrian thaler coined in 1780 during the reign of Maria Theresa. Mr. Robinson urges a large importation of these coins as a measure to promote trade and discourage slavery. He has shown himself to be a diligent student and a good observer, although a somewhat diffuse writer, and the suggestion is worthy of consideration.

In the preface we are told that the Royal Geographical Society's system of spelling place-names has been followed; but this is only done in part. The French transliterations are used in some cases, and also other forms—as, for example, Abutshi, Bornou, Gandja, Soudan, Tchad; where the system referred to would require—Abuchai, Bornu, Ganja, Sudan, Chad.

It is to be hoped that the efforts of the Hausa Association will not be allowed to cease for want of money; for Mr. Robinson's linguistic work is of real value, and its importance will appear more fully when the facsimiles and translations of the Hausa MS. which he has brought home, together with his dictionary and grammar of the language, are published.

OUR BOOK SHELF.

Practical Mechanics, applied to the Requirements of the Sailor. By Thomas Mackenzie, Master Mariner, F.R.A.S., &c. Pp. xii + 175. (London: Charles Griffin and Co., Ltd., 1896.)

This book is one of a very useful series on nautical subjects, published in order to meet a desire on the part of the officers of the Mercantile Marine to obtain a more scientific insight into the principles of their profession.

It is becoming more generally recognised that the really "practical" man is the one who combines practical knowledge and experience with intelligent appreciation of underlying principles.

The aim of the book is to lay before sailors, in an easily comprehended manner, the principles on which the various mechanical devices employed by them are founded.

A large amount of useful information has therefore been gathered together in the small compass of this book, and rules and principles whose *general* application is explained in various text-books on practical and applied mechanics, are here specially adapted to the requirements of the sailor. To mention a few instances: we find explanations of the mechanical advantage gained by the various tackles and purchases; the construction of derricks and shears, and the weight they will support; the relative strengths of ropes; the breaking strains of spars; the floating power of spars and casks, and the weight which a raft, constructed of given materials, will bear; the effect of the wind on the sails in driving the ship ahead and in causing leeway; the effect of the water on the rudder; the extra strain thrown on slings when a ship is rolling, &c.

The principles of the composition and resolution of forces, and of the mechanical powers are somewhat fully explained in the opening chapters, and the idea of applying the traverse table, so familiar to all sailors, to the solution of the problems, is an excellent one; but more explanation of some of the rules given later, which have to be taken for granted, could be desired, as it is very difficult to retain bare rules in the memory.

The size of the book no doubt imposed limits on the amount of space to be devoted to explanation, but it provides, nevertheless, an excellent book of reference; and though it may not be necessary to make some of the calculations referred to, it is always useful to know how things are worked, and on what principles, and that the principles are in accordance with well-known physical laws. "A sailor is so often thrown on his own resources, and the more exact his knowledge is of natural forces, the more readily can he avail himself of the forces at hand."

The book contains several valuable tables, and a useful collection of rules in mensuration.

F. C. STEBBING.

Power Locomotion on the Highway. By Rhys Jenkins, M.I.Mech.E. Pp. 64. (London: William Cate, Ltd., 1896.)

THE sub-title of this publication sufficiently expresses the character of the contents; it is "a guide to the literature relating to traction engines and steam rollers and to the propulsion of common road carriages and velocipedes by steam and other mechanical power, with a brief historical sketch." The historical sketch is a concise statement of the lines along which progress in power locomotion on common roads has proceeded. Following it is a bibliography of works on mechanical carriages and traction engines, a catalogue of papers read before, or appearing in the Transactions of, scientific and technical societies, indexed under names of authors, a list of journals devoted to the mechanical carriage movement, and an index to articles on the subject in periodical literature up to the end of 1895. The periodicals indexed include those of the United States, France, and Germany, as well as of Great Britain. The author has evidently been at considerable pains to prepare his descriptive index, and his efforts deserve encouragement. It would be an immense boon if indexes of the same description were available for other branches of technology. The reception afforded to this little book will show whether the demand is sufficient to justify the publication of others of a like kind.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Utility of Specific Characters.

I REGRET very much that I did not correctly remember, when writing to NATURE a month ago, what my friend Mr. Thiselton-Dyer had said at the Linnean Society's meeting. I suppose that in consequence I must not greatly complain that whilst telling us what he really did say, my friend has taken the opportunity to present a version of my views which is far from accurate. He has less excuse than I had in attempting to cite his remarks, since he has before him my printed letter of July 16. This fact also renders it easy to show wherein he is inaccurate.

I suppose that we are all agreed that it is in the highest degree interesting to know what Mr. Darwin himself thought and said on questions of the kind now under discussion. At the same time, we are none of us, I imagine, likely to attribute to Mr. Dyer a special knowledge either of Darwin's writings or of their interpretation which we do not share. Naturalists are, I believe, not prepared to accept any individual as the authoritative exponent of Mr. Darwin's teaching. Under these circumstances it is to me a matter for regret that a plain discussion of the question whether specific characters are invariably useful should be turned into a dispute as to whether the person who suggests some special application of Mr. Darwin's doctrines, or advances some subordinate hypothesis in relation to their application, can or can not be solemnly regarded as an Orthodox Darwinian. Mr. Dyer says that the Darwinian theory seems hardly to have a convinced supporter left except Mr. Wallace. He denounces my quotations from Mr. Darwin's own books as to correlation of variation as a "difficulty" brought up by me "against" the Darwinian theory; then, without more ado, assumes the *rôle* of apostle of the Darwinian theory (a part to which I cannot allow him any exclusive claim), and proceeds to tell us what "will" be found in the twenty-fifth chapter of Mr. Darwin's "Animals and Plants under Domestication," viz. that Darwin has said pretty much all that can (as yet) be said about the facts of correlation of variation. The attempt on Mr. Dyer's part to represent my citation of Mr. Darwin's own conclusions in regard to correlation of variation as unorthodox, is a little beside the mark. No one is ignorant that it "will" be found that in the chapter cited Mr. Darwin discusses "correlation"; not only that, but it *has been* so found long ago and repeatedly by many other readers besides Mr. Dyer. I expressly stated, both at the Linnean Society and in my letter printed in NATURE on July 16, that I was quoting from Mr. Darwin both as to Wells and as to other instances.

Perhaps the most unsatisfactory feature in Mr. Dyer's claim to classify his friends as heterodox and orthodox in regard to Darwinism, is that it leads him to undertake to give away the Darwinian theory. "I frankly admit," he says, "that such a case [a case of correlated variation such as that hypothetically stated by me] if completely established would give the utility of specific characters, and with it the Darwinian theory, a serious blow." I do not value this frank admission. If Mr. Dyer feels constrained to admit to some one that such a case would give a serious blow to the Darwinian theory, he must not come to me with his "admission" of a "point scored"; for I neither admit that any such blow is given, nor can I accept Mr. Dyer's good-natured offer to act as representative of the Darwinian theory. All that my friend can represent in this matter is the Dyerian theory of Mr. Darwin's theory. Mr. Darwin never asserted in so many words that specific characters are invariably "useful," and in my judgment he did not hold that opinion. But whether he did or did not, that opinion can not, I think, be shown to be a necessary outcome of the theory of natural selection, provided that we take into consideration important ascertained properties of living matter. My impression is that Mr. Wallace—whom Mr. Dyer has declared to be the only convinced supporter of the Darwinian theory now left—stated at the Linnean Society that he agreed with me as to "correlated variation" sometimes accounting for a specific character which accordingly could not be regarded as due to utility. Such also I gathered was the view of Mr. Meldola. Yet neither of these gentlemen regarded this conclusion as a serious blow to the Darwinian

theory. Nor do I; on the contrary, I regard it as an important aid to the general application of the Darwinian theory.

Apart from the objection, which I have above expressed, to the treatment of this question by Mr. Dyer as one of orthodoxy, I note with regret that he has (unintentionally no doubt) misrepresented what I have actually said in my letter. Whereas I have expressly cited Mr. Darwin's principle of "correlation of variations," Mr. Dyer writes of the "extended correlation principle of Prof. Lankester." This form of pleasantry could be itself extended, but more of it would be unworthy of your pages. As a matter of fact, what I said as to correlation was very little more than a citation of cases and their theoretical explanation given by Mr. Darwin. To represent this as in any way parallel to the independent and anti-Darwinian theories of Mr. Romanes and Mr. Bateson, as is done by Mr. Dyer, is misrepresentation. The theory of Wells as to the black races of the tropics was used by me in order to illustrate my suggestion as to correlation leading to a development of useless specific characters. I might, equally well for my purpose, have used any of the other cases collected by Mr. Darwin. Whilst I spoke of Wells' case as "striking and suggestive," I at the same time expressly referred to it as "a more or less hypothetical case." Mr. Dyer has no justification, so far as I can see, for stating that I use this case as a foundation for wide generalisation. I made no wide generalisation, but adduced the wide generalisation at which Mr. Darwin, after collecting and considering a large variety of cases, arrived, viz. that correlation of variation does occur largely and generally in the organic world. This wide generalisation is, I say, not mine; it is Mr. Darwin's. If this generalisation be accepted—and we may reasonably hope that the apostolic and orthodox do accept it—then it seems to me in the highest degree probable that an obscure specific difference of structure—highly effective as life-preserving or progeny-ensuring—will more or less frequently carry with it as a correlated variation a more obvious and measurable character in some remote part of the body, not effective, that is to say, not useful. Hence I conclude that there may be specific characters (not by any means all or always) which are not themselves *useful*, though readily observed. That is the whole of my contribution to the present discussion. It does not seem to me to involve anything rash or surprising, though such is its character according to Mr. Dyer.

I may remind the readers of NATURE that some years ago, in these columns, I adduced this same principle, viz. Mr. Darwin's principle of correlation of variations, as one sufficient to remove some of the difficulties in the way of the doctrine of natural selection brought forward by the Duke of Argyll. What the Duke called "prophetic germs" might, it seemed to me (and still seems to me), when not explicable as lapsed rudimentary structures, be accounted for as variations or new structures correlated with other useful and therefore selected variations, although not yet themselves useful. A useless variation correlated with a useful one must (it seems to me) be supposed to pass through initial stages in which it is too small, or otherwise insignificant, to be useful (its utility or harmfulness being swamped in the utility of the correlated useful character), and only after attaining considerable development becomes either useful or harmful, and therefore subject to selection, possibly under some slight change of environment.

I regret all the more my differences with my friend Mr. Dyer, because the explanations they have involved leave me so little space in which to refer to Prof. Weldon's courteous and interesting letter. I have only one point to correct in his statement of my position in relation to that taken by him. The attempt to reconcile the *dicta* of Hume or Kant, or even of Mill, with the experience and approved practice of those who make it their business to investigate natural phenomena, would be an interesting undertaking, possibly one beyond the powers of living man. It is certainly not one upon which I shall here and now embark.

The point whereon Prof. Weldon has misunderstood my contention is this. After describing a phenomenon (death-rate) preceded invariably by two or more phenomena of structure or function, he says: "Under these circumstances, Prof. Lankester thinks it legitimate to pick out one of these antecedent phenomena and to speak of it as the only effective cause of change in death-rate, the other phenomena, although equally universal, being merely unimportant concomitants of this one essential change." Prof. Weldon is mistaken in stating that I think it legitimate "to pick out" without qualification, or at haphazard, any one of these antecedent phenomena, and to speak of it as the only effective cause. I should object to such a proceeding on much the same ground as that on which I object to his calling "any and all" of those antecedent phenomena effective causes.

What I think is the reasonable course in such a case—supposing that a man wishes to ascertain, as fully as may be, the relation of these phenomena to one another, is that he should frame in his mind a hypothesis as to how any one or more of the phenomena, invariably associated with a given death-rate, can operate so as to effect an increase or decrease in that death-rate. This, no doubt, will require a large knowledge of the surrounding conditions not usually to be acquired with ease, and an analysis of the antecedent phenomena in question, often of a prolonged and laborious character. Sometimes, however, such a hypothesis will present itself very readily and with much antecedent probability. However attained, the hypothesis will remain merely a guess until it is tested. It can be tested either by experiment or by observation of appropriate natural instances. By repeated testing, involving often great ingenuity and prolonged labour, the hypothesis is either confirmed or discarded; possibly a new hypothesis is adopted, so to speak, *en route*, and established as in all probability true. When—and not until—this process has been gone through, the naturalist will be, more or less according to the extent of his work, in a position to *place* the phenomena in their true relation to one another and to the ultimate phenomenon proposed for investigation, viz. death-rate. If the study of the antecedent or associated phenomena by means of hypothesis and test-experiment has not been and cannot be carried out, the naturalist can not (it seems to me) reasonably either "pick out" one of them and assert that it is the cause of increased or decreased death-rate, nor (still less) declare that all the antecedent or associated phenomena are the causes and produce the effect of increased or decreased death-rate. If he does do so, he appears to me to be evading the task before him, which is to "explain," that is, to place in their true order and relation a complex group of related phenomena.

The appeal to analogy no doubt frequently leads naturalists to rapid conclusions as to the causal relations of the phenomena of organisms. Often (but by no means always) such conclusions are erroneous: but it is not on that account desirable to reject the argument from analogy in reasoning about such matters. It must be used with knowledge and with caution. It seems to me, that in considering a complex case in which actual experiment is as yet wanting, it is often more useful to formulate provisional conclusions as to what is cause and what only concomitant effect by the aid of argument from analogy, than to deliberately reject all attempts at analysis, and to "lump" all the constantly associated phenomena as "causes." Surely in the case of Prof. Weldon's crabs, most naturalists would take the view that the frontal measurements may *possibly* be operative in saving the life of the crab, or *may* be only a correlative of some other life-preserving structure; that its quality in this respect should be inquired into by means of hypothesis and experiment; and that, until this is done, it is *premature* to speak of a particular frontal proportion as having for its *effect* the survival of those crabs distinguished by its possession.

The chief task of the student of living things seems to me to lie in the search for such explanations, even though the task is in some cases to all appearance at first sight hopeless, and even though too hopeful and imaginative spirits may be led, not unfrequently, to propound explanations which are insufficiently supported by observed facts, or are demolished by the observation of other facts. You can not (it seems to me) reduce natural history, as Prof. Weldon proposes, to an unimaginative statistical form, without either ignoring or abandoning its most interesting problems, and at the same time refusing to employ the universal method by which mankind has gained new knowledge of the phenomena of nature—that, namely, of imaginative hypothesis and consequent experiment. I think that most naturalists will agree with Johannes Müller that "Die Phantasie ist ein unentbehrliches Gut." E. RAY LANKESTER.

Dinard, Bretagne, August 10.

Habits and Distribution of Galeodes.

WILL you be good enough to publish in your widely-read paper the following notes on the geographical distribution of *Solfuga* (*Galeodes*) *araneoides*, as the published accounts of that arachnid are incomplete in that respect.

In India it is found in the central parts of India, in the Punjab, in Afghanistan, in Baluchistan. Probably it will be found in Rajputana and Scinde, and perhaps in some parts of the Dekhan. I have never found it in the alluvial plains of Northern India, nor in Bengal. I have just found it in the Eastern Sudan. Probably it exists in most of the deserts of Asia and Africa. The ones I have found all seem to belong to one species. They are of a light straw colour, often with some black above. A black variety is found on the Afghan frontier. The biggest specimen measured 1¾ inches from the tips of the jaws to the end of the abdomen. They feed on soft insects like moths, and live in holes on the ground. They are very rapid in their movements, and are difficult to catch when on the move. The best way to get them is to put a glass over them when they are lying still in a corner. A big match-box often acts as a good trap. They will run inside it of their own accord. They go up walls, posts, trees, in search of insects, and will jump down from a fair height.

The movements of their jaws when feeding presents a unique sight. The head is small, and the bases of the jaws are bulbous and look like a continuation of the head. When eating they move their jaws alternately, and one gets the impression that the head is jointed and that each side moves alternately. In encounters with spiders, scorpions and centipedes, they usually fare badly. Their belly is so soft, that once caught there, they are done for. Still they are very combative.

I have often tried to settle the point as to whether their bite is painful or poisonous. But I never could succeed in making one bite a human being. E. Cretin.

Suakin Force, July 12.

[The genus Galeodes, represented by several species, is known to extend in Africa from Algeria to Egypt, thence southwards into Somaliland; in Europe, from Greece throughout the steppes of South Russia; in Asia, over the whole of Asia Minor, Arabia, Persia, Baluchistan, Afghanistan and Turkestan, and thence into India, where it has been recorded from the following localities: Punjab (Kohat), Rajputana (Bikanir), Gwalior, Delhi, Secunderabad, Guntakul near Bellary, Birhbum, Bengal and Madras.—R. I. Pocock.]

Nest-building Amphipod in the Broads.

It will be remembered that in 1891, *Cordylophora lacustris* was found in great abundance in Heigham Sound. On the 6th inst,, after collecting in that locality and downward to Potter Heigham Bridge, I noticed at the bottom of the bottle a Crustacean, apparently a Podocerid. On floating a piece of reed stem, covered with colonies of the hydrozoon, in a vessel of water, it was evident that the colonies were thickly studded with nests, from which, in some cases, the antennæ were seen protruding. Several specimens of these Amphipods were secured at once; and these the Rev. T. R. R. Stebbing, F.R.S., has kindly identified. They prove to be *Corophium crassicorne*, Bruzelius. A large colony of the Cordylophora has been preserved in formalin, with the nests. On the following day I met with the same Amphipod, in considerable numbers, between Acle Bridge and the Angel Inn. Henry Scherren.

9 Cavendish Road, Harringay. N.

The Effects of a Strong Magnetic Field upon Electric Discharges in Vacuo.

Some interesting experiments upon the subject of this note were described in Nature, July 19. A small addition to those experiments serves to show the connection between the electric conductivity of the tube and the mean free-path-length of the included molecules.

Using the same form of Crookes' tube as employed by Mr. Swinton, but provided with the platinum Maltese cross to intercept the kathode rays, the shadow of the cross is rotated upon its centre through an angle depending upon the strength of the magnetic field. The motions therefore of the molecules are changed from right lines to spiral lines, and thus their free paths are lengthened—a result equivalent to a further exhaustion of the tube The primary effect of the magnetic field, observed by Mr. Swinton, was an increase of conductivity in the tube. The two experiments therefore show that the conductivity in the tube increases with lengthening of the free paths.

By lowering the tube slowly from a few inches above the pole of the electro-magnet down to contact, the shadow of the cross is seen to rotate slowly, and to become smaller as the luminescent cone contracts to the form shown by Mr. Swinton, with the apex on the bulb.

The rotation of the shadow is reversed by reversing the poles of the magnet; and when the current is reversed in the tube, the green fluorescence appears as a spiral band round the walls of the tube—a right-handed or left-handed helix, according to the polarity of the magnet. Walter Sidgreaves.

Stonyhurst College Laboratory.

THE LIVERPOOL MEETING OF THE BRITISH ASSOCIATION.

THE detailed local arrangements are now progressing rapidly. St. George's Hall, where the reception room and offices will be situated, has just been re-painted and decorated by the Corporation at great cost. The old wooden flooring has been removed so as to expose the beautiful tiled pavement, which has not been seen for many years, and which will not be covered up again until after the meeting. The buildings and rooms allotted to the various Sections were mentioned in the former article. The sectional fittings have now been planned out, and will be commenced at once. Separate electric and oxy-hydrogen lanterns will be provided for all the Sections that desire them. A large lecture theatre, holding over six hundred people, at University College, will be available for joint discussions between the Sections.

The details of most of the excursions have now been arranged, and a special "Excursions Guide," in addition to the "Handbook," has been prepared. Amongst the excursions, that to the Isle of Man at the conclusion of the meeting will probably take a foremost place, both on account of its general attractiveness and of its special scientific interest. This excursion will extend over five days—from Thursday, September 24, to Monday, September 28, inclusive; and the party will break up into four Sections: (1) Archæologists, (2) Geologists, (3) Zoologists, and (4) Botanists, to be conducted by competent leaders over those parts of the island which offer special attractions for scientific study. The geology of the island is varied and interesting, especially as regards the dynamic alteration of the older Palæozoic rocks, the volcanic series and the richly fossiliferous limestones of Carboniferous age, and the wide developments of the glacial deposits; the Prehistoric, Scandinavian, and other early remains are celebrated; the marine fauna and flora are abundant, and the presence of the Liverpool Marine Biological Station at Port Erin affords facilities for dredging expeditions and other biological work.

The detailed programme for the four Sections, which follows, has been arranged by a Committee of the Isle of Man Natural History and Antiquarian Society, acting along with representatives appointed by the Liverpool Executive Committee; and a special appendix to the Liverpool "Handbook," containing an account of the geology, antiquities, and natural history of the island, illustrated by a geological map and a chart, has been drawn up by Mr. P. M. C. Kermode, Mr. G. W. Lamplugh, and Prof. Herdman.

Section I.—Archæologists.

Leaders: Arthur J. Evans, P. M. C. Kermode.

Thursday, 24.—Arrive by steamer from Liverpool about 3 p.m. Reception by his Excellency the Right Hon. Lord Henniker, Lieut.-Governor, at Government House. Headquarters at Douglas.

Friday, 25.—Carriages at 9.30 a.m. for Braddan (see ancient crosses and alignments), St. Trinian's, then Tynwald Hill (see mound, cist, Runic cross, &c.). Lunch at Creg Malin Hotel, Peel, at 1 p.m. See Peel Castle, round tower, cathedral, and crosses. Drive to Crosby,

Ellerslie, and Ballingan Chapel. See Glen Darragh Circle, and then back to Douglas.

Saturday, 26.—Train at 9.30 a.m. to Castletown; arrive Castle Rushen 10.30. See Castle collection of antiquities, &c. Train 12.22 for Port Erin. Lunch 1 p.m. Visit Liverpool Marine Biological Station. Walk to Neolithic Circle on Meayll Hill, then to Cregneish (see chasms), then to Port St. Mary (see Oghams and standing stones). Train to Douglas.

Monday, 28.—Train at 9.35 a.m. to Ramsey. Stop at Sulby Glen at 10.42. Climb Cronk Sumark (see ancient fort). Train to Ramsey, arriving at 1.10 p.m. After lunch visit Masonic Rooms (see casts of crosses, flint implements, &c.) Carriages to Laxey (see King Orry's grave). Electric railway to Baldrine (see ancient fort and "cloven stones"), Keeil Killane (lintel graves), then on to Douglas. The four Sections will dine together at the Sefton Hotel, Douglas, on Monday evening.

SECTION II.—GEOLOGISTS.

Leaders: Prof. W. Boyd Dawkins, G. W. Lamplugh.

Thursday, 24.—Reception at Government House, &c., as before. Headquarters at Douglas.

Friday, 25.—Train at 9 30 to Castletown, walk to Castle Rushden, and then on to Stack of Scarlet, and thence to Poyllvaaish (see carboniferous limestones and contemporaneous volcanic series). Meet carriages at Poyllvaaish, lunch at George Hotel, Castletown, and drive to Langness (see base of carboniferous rocks and Skiddaw slates), and then on to railway station at Ballasalla. Train to Douglas.

Saturday, 26.—Electric Railway at 9.30 a.m. to Laxey, and on to Snaefell. (General view of island, and metamorphism of Skiddaw slates). Meet carriages near the Hut, and drive to Tholt-y-Will. Lunch 1 p.m., drive down the Glen, stopping at various points (see crush-conglomerates of Skiddaw rocks, &c.) on the way to Ramsey. Steamer at 6 p.m. back to Douglas.

Monday, 28.—Carriages at 9.30 a.m. for Crosby, Rockmount (see intrusive dykes in Skiddaws), Lhoob-y-Reeast, Peel (see red sandstones, &c.). After lunch see Peel Castle, &c. Drive to Foxdale (see lead mines and granite outcrop), and then on to Douglas. Final dinner with the other Sections.

SECTION III.—ZOOLOGISTS.

Leaders: Prof. W. A. Herdman, I. C. Thompson.

Thursday, 24.—Reception at Government House, &c., as before. Train at 5.10 p.m. for Port Erin.

Friday, 25.—If the weather is suitable, the day will be spent in dredging, &c., from a steamer, probably to the west of the Isle of Man. If dredging is impossible there is shore collecting, tow-netting in the bay, and work in the Biological Station to fall back upon.

Saturday, 26.—Train at 10.40 to Castletown (see Castle Rushen). Return to Port Erin. Lunch at Bellevue Hotel. Take Section I. over Biological Station. Walk with Sections I. and IV. to Neolithic Circle on Meayll Hill. See Cregneish, chasms, &c., and return to Port Erin.

Monday, 28.—If weather is suitable take steamer to Ramsey, dredging on the way along the east side of Island. Lunch at Ramsey, 1 p.m. (If time permits, join Section I. in seeing collection at Masonic Rooms.) Dredge from steamer on way back to Douglas. Final dinner, and stay night at Douglas.

SECTION IV.—BOTANISTS.

Leaders: Prof. F. E. Weiss, Rev. S. A. P. Kermode.

Thursday, 24.—Reception at Government House, &c., as before. See Mr. Okell's garden and collection of Veronicas. Train at 5.10 (with III.) to Port Erin.

Friday, 25.—Carriages 9.30; drive by "Round Table" to Peel over the mountains. Lunch (with I.); see Castle, &c. Carriages to Foxdale, Malew, and back to Port Erin.

Saturday, 26.—Train (or walk, by shore) to Castletown. See Castle Rushen (with I. and III.). Train to Port Erin. Lunch (with I. and III.). Visit Biological Station and Port Erin Shore. Walk with I. and III. to Neolithic Circle on Meayll Hill, on to chasms, and back to Port Erin. There is good shore-collecting at Port Erin, at Port St. Mary, and at various intermediate points.

Monday, 28.—Train to Douglas; carriages to Laxey. Electric railway to Snaefell. Meet carriages near Hut; drive to Tholt-y-Will. Lunch 1 p.m. Drive down Glen and through Curraghs (marsh plants) to Ballamooar, Jurby (gardens, conifers, &c.), back through Curraghs to Ballaugh railway station. Train to Douglas. Final dinner, and stay night at Douglas.

Some changes are taking place in the list of foreign guests. A few of those who had accepted, find themselves unable to be present; but others who were not expected, or were doubtful, are now coming, including some foreign Professors of medicine, surgery, and allied medical subjects—no doubt out of compliment to the President-elect. The local medical men are organising various arrangements in honour of Sir Joseph Lister.

The Local Secretaries hope to secure Dr. Nansen's presence at the meeting. Before he sailed in the *Fram*, Nansen promised a Liverpool shipowner that he would visit him immediately on his return. He has now been reminded of that promise by telegram to Vardö.

It is becoming possible now to forecast to a considerable extent the scientific work which will be brought before this meeting of the Association, and in a further article next week we shall give a sketch of what will probably be the leading features of the various Sections.

W. A. HERDMAN.

COUNTY COUNCILS AND AGRICULTURE.

THE allocation of public money to County Councils under the Local Taxation (Customs and Excise) Act of 1890 has now been in progress for half-a-dozen years. It was understood, though not expressly stipulated, that this money—the proceeds of an additional tax placed upon beer and spirits—should be devoted to the furtherance of technical education, and in the case of most County Councils it is to this object that the money has been applied. With reference to the permanency of the grant, the Duke of Devonshire (then Lord Hartington), addressing a meeting on December 5, 1890, said: "The best way of securing the fund will be to see that it is used for the purpose for which it was originally granted." And on the previous day, in the House of Commons, Mr. Goschen, at that time Chancellor of the Exchequer, said, in reply to a question: "If County Councils set themselves heartily to work to utilise the grants for important educational purposes, it will probably be difficult for any Minister to persuade Parliament to divert them." Excepting in a few cases where some or all of the grant has been applied to the relief of local rates, the County Councils appear to have loyally adhered to the understanding in accordance with which the money was originally directed into the new channel. The particular form of "important educational purposes" to which aid has been extended has necessarily varied somewhat in different localities, but, on account of the universal pursuit of the industry, agriculture perhaps has received more wide-spread recognition than any other art. The result has been the establishment within recent years of new agricultural colleges and schools, or the grafting of an agricultural department upon educational institutions already in existence. To a third group may be assigned

various organisations which were in operation before the days of County Councils, but to which these latter have felt it right to hold out a helping hand. To what extent these different bodies are carrying out the objects for which they were instituted, is a fair subject of inquiry.

In most cases evidence is forthcoming of two main lines of activity, which, though independent of each other, are nevertheless related. These are on the one hand the instruction of students, and on the other the prosecution of investigations which should prove of interest not only to students but to all who are engaged in agricultural pursuits. Under the first head there is not much room for novelty. The model which was set up when, more than fifty years ago, a small group of far-seeing men—the Prince Consort amongst them—unfurled upon the Cotswold Hills the banner of agricultural education, is the one that, consciously or unconsciously, has always been followed. In all attempts that have since been made to formulate a fairly comprehensive scheme of agricultural tuition, the germs of every system will be found in the curriculum of the Royal Agricultural College, Cirencester. Nevertheless, this curriculum, far from being stereotyped or crystallised, is and always has been susceptible of such modifications as are called for by the exigencies of the times, as was exemplified by the manner in which the dairying industry, at the time of its renaissance, received prompt and adequate recognition. Its permanence, indeed, is due to its elasticity. Many hundreds, perhaps thousands, of students are now receiving in agriculture a good type of technical instruction which a score of years ago could be obtained nowhere else in this country than at Cirencester.

It is to that section of their work in which institutions fostered by County Councils are brought more immediately under the notice of the general public that criticism may be usefully directed. Most agricultural colleges and schools, and probably the agricultural departments of all university colleges which possess them, are engaged in pursuits which may or may not deserve to be dignified by the name of research. In the majority of cases, however, the work is nothing else than demonstration, and it usually takes the form of differential manuring experiments upon various crops in the field. Periodically, reports are published embodying the results. These are noticed in our columns, but we are not often able to point to any work that rises above the level of demonstration, of the same type as the example fields and example crops that are conducted under Government auspices in France. In most instances the results can approximately be stated beforehand. If it is necessary to demonstrate in a number of localities the effects of nitrogen according as it is applied to a crop in the form of nitrate of soda or of sulphate of ammonia, or to show the different effects of basic slag, bones, and superphosphate of lime as sources of phosphorus—to cite these as simple illustrations—then, no doubt, these many-duplicated field experiments serve their purpose. Nevertheless, they do not alter the fact that the best experimental farm—the one that is capable of teaching the most useful lessons—is a farmer's own occupation, for in this case the conditions are known to him with, perhaps, a minuteness of detail that cannot be approached in connection with field experiments in which he is hardly likely to take more than a sort of academical interest. What have the County Councils, through the medium of the institutions to whose support they contribute, yet done towards teaching the farmer to read aright the lessons which he may learn all the year round in his own fields, and the capacity to make correct inferences from which would be invaluable to him?

It is noteworthy that, with hardly an exception, the work of these institutions is restricted to crops and cropping. The fascinating problems associated with animal nutrition have mostly failed to attract them. Perhaps these are considered too difficult, possibly they may be thought too costly. In one or two cases the domain of bacteriology has been invaded, particularly in connection with dairying. A good illustration of the general character of the work undertaken is provided in the current report of the Board of Agriculture on the distribution of grants for agricultural education. In the financial year 1894-95 the Board distributed the sum of £7400 amongst seventeen institutions. It is not very obvious why these institutions and none others were selected, but it is a fact that all, or most of them, are also in receipt of County Council grants. It is stated that, in at least twenty counties of England and Wales, "demonstrations by experimental work in field plots are now undertaken," and *résumés* are given of the work recently done at the institutions which have received grants from the Board.

Altogether it would seem that, whilst the institutions under notice are undoubtedly useful as instruments of agricultural education, their value in other directions might be increased were their labour less diffuse. The boast that a given centre has more fields of demonstration scattered over a larger number of counties, and that its officials have travelled a greater aggregate of miles in the discharge of their duties, than in the case of any other centre, may be gratifying to local pride, but it is not a high object to aim at. There may possibly exist an ambition to make a centre a second Rothamsted, but it must be remembered that it is the "continued effort along a given line," associated with "the limited number of lines undertaken, although the work extends over fifty years," that has secured for Rothamsted its unique reputation. The warning has already gone forth officially to the United States agricultural experiment stations, that concentration of energy upon a few specific objects of investigation is preferable to the diffuse expenditure of force which has hitherto characterised many of the stations. There is no coordinated effort amongst our own institutions; each goes its own way, independent of, and practically ignoring, the others—unless, perchance, there be rivalry. A connecting link, possibly a controlling influence, is needed. Youth is on their side, and they have furnished many proofs that they are not lacking in energy. Quality rather than quantity, however, is the goal at which they should aim in the future conduct of their work.

THE ECLIPSE OF THE SUN.

THE bad news which we published last week regarding the almost general failure of the eclipse observations is tempered by the telegrams which have since been received regarding the weather in Novaya Zemlya and in Siberia.

A telegram from Hammerfest reports success at the former station, though details are yet lacking. As this expedition was organised at the last moment, very little has been said about the instruments to be employed. It may be stated, therefore, that Sir G. Baden-Powell took with him Dr. Stone, of the Radcliffe Observatory, who proposed to make spectroscopic observations, and Mr. Shackleton, one of the computers employed at the Solar Physics Observatory, South Kensington, who observed the eclipse of 1893 in Brazil. Mr. Shackleton was provided by Mr. Norman Lockyer with a powerful prismatic camera with two 3-inch prisms of 60°, and careful testings gave great hopes of its performance.

It was, therefore, to be employed chiefly in investigating the special spectrum of the corona found on the photographs of 1893. As a subsidiary instrument, a telescope of four inches aperture and somewhat long focal length was also arranged to photograph the corona. Both instruments were to be fed with light by a Foucault siderostat.

It is hardly necessary to remark that these instruments are capable of furnishing results of the highest value to solar physicists. We therefore note with satisfaction the still later Reuter telegram from Hammerfest, dated August 17:

Sir George Baden-Powell's yacht *Otaria* has arrived here all well with the members of the British Eclipse Expedition. The party made excellent and valuable observations of the eclipse in Novaya Zemlya. The corona and spectrum were clearly visible, and very satisfactory photographs were taken.

The following telegrams from Russia inform us that one of the parties from Pulkowa, including the excellent spectroscopist Belopolsky, has also been successful.

St. Petersburg, August 15.

According to a telegram from Tiumen, in Western Siberia, the solar eclipse was very successfully observed at that place, and one particularly good photograph was taken. Some stars even are visible.

August 16.

A despatch from Khabarovka, which is the residence of the Governor-General of the maritime territory in the extreme east, states that the astronomical observations of the eclipse taken in the village of Orlovski, on the river Amur, were thoroughly successful. The weather was fine during the eclipse. The astronomers, MM. Belopolsky, Vitram, and Orbinsky, have returned to Khabarovka.

August 18.

A telegram from Khabarovka gives further details of the astronomical observations of the solar eclipse taken on the Amur. The sky at the time was overcast, but during totality the corona and several stars of the first magnitude were distinctly visible through the telescope. The darkness was not complete. Six photographs were taken illustrating the different phases of the eclipse.

We referred last week to the partial success on the west coast of Norway. Mr. John Dover has communicated a letter to Tuesday's *Times*, from which we make the following extract:—

It was thought that the best view would be obtained from a village, Brevik, about twenty miles south-east of Bodö. Leaving Bodö on Saturday evening by steamboat, we passed through the "Saltström" at low tide, and waited near to watch the waters rushing into the fiord as the tide rose. We then proceeded to the village of Brevik, where we landed at two o'clock on Sunday morning. A climb of about twenty minutes brought us to a suitable elevation above the fiord of about 250 feet from whence there was an uninterrupted view to the north-east and east for some miles. Only one small cloud was visible, and that in the west; otherwise the sky was quite clear. There was a perfect sunrise at 3.14 on Sunday morning. The partial eclipse began at 4.1 a.m. The total eclipse began at 4.54, and lasted for 92 secs. At Vadsö the totality would have been 105 secs. The partial eclipse ceased at 5.51. At 4° 54′ 45″, the middle of the eclipse, the sun being completely hidden, the corona around it assumed a distinct form. The corona to north-east was about the length of the sun's diameter and very distinct. On the western edge the corona was about two-thirds the length of the sun's diameter, while to the south-east it was about half a diameter. To the north the corona was very slight indeed, being about one-tenth of a diameter. On the south-western edge of the sun appeared a large red spot which was visible until the totality of the eclipse had quite ceased. A Dutch professor near me observed two small spots on the eastern side, but these escaped my notice. I glanced away from my telescope for a moment to see if any stars were visible, and observed Jupiter and Venus. Mercury and Regulus were also seen by others present. The colour of the moon in front of the sun seemed of a dull grey, while the corona around the sun was of a light cream colour. The sky to north and east appeared of a pale orange colour, while to the west it was of light yellow shade. Two photographers—one from Flensborg, Schleswig, the other an amateur from Oxford—were at work, so that I hope a good photograph of the eclipse may be produced. My great regret was that I did not see any one present with thoroughly good scientific instruments.

We shall publish next week a letter received from Mr. Norman Lockyer, containing an account of the preparations he made to observe the eclipse on the Island of Kiö, assisted by the officers and men of H.M.S. *Volage*. Sir Robert Ball contributes to Wednesday's *Times* a long letter on the observing parties and stations at Vadsö and in the neighbourhood, and Dr. Rambaut makes a similar contribution to the *Daily Chronicle* of the same day. We must also mention that the correspondent of the *Daily Telegraph* gives some interesting notes on the characteristics of the shadow.

NOTES.

The current number of the *Comptes rendus* of the Paris Academy of Sciences contains a statement, by M. Berthelot, with reference to the present condition of the scheme to erect a monument to Lavoisier by international subscription. A Committee to take this matter in hand was formed, in 1894, of members of the Institute of France, and representatives of the French Government, of the Municipal Council of Paris, and of various scientific bodies. A special Committee was nominated to obtain subscriptions, and the result of their appeal has now been made known by the publication of a list of subscribers in a fasciculus issued with the *Comptes rendus*. The amount already received is 47,553 francs (nearly £2000), and subscriptions are still coming in. The Emperor of Russia has authorised the opening of a subscription list in Russia, and has headed the list with a sum of two thousand roubles (£313). The French Minister of Public Instruction will give six thousand francs (£240), and the City of Paris £400. Alsace has contributed 2475 francs (nearly £100) to the fund, Germany about £160, England £130, Austria-Hungary £100, Belgium £24, United States £20, Greece £7, Italy £40, Mexico £4, Netherlands £40, Portugal £24, Roumania £14, Servia £40, Norway and Sweden £80, Switzerland £34. The construction of the monument has been entrusted to M. Barrais.

A strong and representative Committee is being formed in connection with the proposal to inaugurate a memorial to commemorate the inception and extension of submarine telegraphy. Amongst many other influential persons who have agreed to act are:—Viscount Peel, Lord Kelvin, Lord Selborne, the Lord Chief Justice, Mr. Joseph Chamberlain, Sir Richard Webster, Lord George Hamilton, Sir Juland Danvers, Sir Samuel Canning, Sir Eyre Shaw, Sir John Robinson, Admiral Sir Henry J. C. D. Hay, Admiral Sir Anthony Hoskins, Mr. Hubert Herkomer, Mr. Herbert de Reuter, Mr. J. C. Lamb, Mr. W. H. Preece, Dr. John Hopkinson (President of the Institution of Electrical Engineers), Dr. Alexander Muirhead, Mr. Alexander Siemens, and Mr. W. S. Silver. An executive will no doubt be formed from the larger Committee, and the *Electrician* makes a suggestion for their consideration. The introduction and extension of telegraphy are almost exactly coincidental with Her Majesty's reign—the magnetic needle telegraph having been patented by Cooke and Wheatstone on June 12, 1837, and the first telegraph line from Paddington to West Drayton being constructed in 1838-9. The suggestion of our contemporary is that the memorial in question should be inaugurated at the time of the celebration of the sixtieth anniversary of the Queen's reign, on or about June 20 next.

The fourth meeting of the International Congress of Hydrology, Climatology, and Geology will be held at Clermont-Ferrand, Puy de Dôme, from September 28 to October 4.

It is announced in *Science* that, if certain conditions are fulfilled by the City of Chicago, the Field Columbian Museum is to receive two million dollars as an endowment fund from Marshall Field, the founder of the Institute.

THE death is announced of Dr. H. E. Beyrich, Professor of Geology and Palæontology, at Berlin.

WE are sorry to see the announcement of the death of Prof. H. A. Newton, of Yale College, whose work in pure mathematics and mathematical astronomy is well known to men of science.

THE list of new Fellows elected by the Reale Accademia dei Lincei of Rome, with their special subjects of study, is as follows:—Ordinary Fellow, Giovanni Briosi (Botany); Corresponding Fellow, Giacinto Morera (Mechanics); Foreign Fellows, Carl Neumann and Hugo Gyldén (Mechanics), Ludwig Boltzmann and Alfred Cornu (Physics).

THE *British Medical Journal* states that the members of the Liverpool Medical Institution have invited Sir Joseph Lister, President-Elect of the British Association, to a banquet to be given in his honour on September 19. The banquet will take place in the Philharmonic Hall, in which the dinner of the British Medical Association was held on the occasion of the meeting in Liverpool in 1882. The Lord Mayor of Liverpool (the Right Hon. the Earl of Derby) will also be the guest of the Institution, and upwards of one hundred of the more distinguished members of the British Association have been invited to be present. The Blue Hungarian Band has been engaged for the evening, and no effort is being spared by the Dinner Committee to make the festival worthy of the guests, the British Association, and the Medical Institution.

AS announced on July 23, the autumn meeting of the Iron and Steel Institute will commence at Bilbao, on Monday, August 31. The detailed programme has now been distributed, from which it appears that the following papers have been offered for reading:—On the Spanish iron industry, by Don Pablo de Alzola; on the estimation of sulphur in iron ores, by R. W. Atkinson and A. J. Atkinson; on the present position of the iron ore industries of Biscay and Santander, by William Gill; on a new water-cooled hot-blast valve, by William Colquhoun; on the manganese ore deposits of Northern Spain, by Jeremiah Head; on the missing carbon in steel, by T. W. Hogg; a note on the presence of fixed nitrogen in steel, by F. W. Harbord and T. Twynam; further notes on the Walrand process, by G. J. Snelus, F.R.S.; on the roasting of iron ores with a view to their magnetic concentration, by Prof. H. Wedding.

WE regret to notice the report that Herr Lilienthal, whose experiments in artificial flight have on several occasions been described in these columns, has been accidentally killed. According to a Central News telegram, he made an experimental journey on August 11, starting from Gömberg, in the province of Brandenburg. He had flown along safely for over two hundred yards, when a gust of wind suddenly caught and carried him upwards, causing him to lose control over his wings, with the result that he fell to the ground, broke his spine, and died soon afterwards. Herr Lilienthal was reported some time ago to have met with a fatal accident, but happily the news then proved to be incorrect. There does not, however, seem to be any grounds for doubting that he has now actually met his death while carrying out one of his intrepid experiments which have been of such assistance in developing the knowledge of the conditions of flight. It is worth remark that Mr. S. E. Peal, in a letter which we published on August 6, prophesied the probability of the occurrence of an accident such as that which has just ended fatally. He said: "Herr Lilienthal is probably on the right trail. I see he desires to turn and meet the breeze; but in this movement, I fancy the upper central aeroplane—so high above the centre of gravity—will turn him over in a strong wind." Unfortunately the suggested accident has happened, and has deprived science of an enthusiastic experimenter in aërial navigation.

A CORRESPONDENT at Johannesburg has sent us a report, from the Johannesburg *Star*, of some amusing speeches recently made in the Volksraad on the subject of rain-making experiments. It would be a pity to let the richness of the utterances of the members of the Raad be the cause of merely local merriment, so we subjoin the report, trusting that sacrilegious meteorologists will give it their consideration. The report is as follows: "The debate on the memorials from Krugersdorp, requesting the Raad to pass an Act to prevent charges of dynamite being fired into the clouds for rain, was continued. Mr. A. D. Wolmarans spoke in favour of his proposal, and denounced the action of certain persons at Johannesburg as invoking the wrath of God. Mr. Birkenstock said there was nothing irreligious or sacrilegious in these experiments; they were purely scientific experiments. When lightning-conductors were first invented, the same objections were raised against their use. This was not a subject for the Raad to deal with, and he moved as an amendment that the Report of the Memorial Committee to decline to interfere be adopted. The Chairman said it was a monstrous thing to shoot into the clouds; it was nothing less than defiance of the Almighty; it should be made a criminal offence. Mr. Labuschagne was of the opinion that the offenders should be imprisoned. After a further discussion it was resolved, by fifteen to ten votes, to instruct the Government to draft a law to prevent such things happening in future, and submit it this session."

THE Committee of the British Association on Zoological Bibliography and Publication desire to draw attention to the following statement:—It is the general opinion of scientific workers, with which the Committee cordially agrees, (1) that each part of a serial publication should have the date of actual publication, as near as may be, printed on the wrapper, and, when possible, on the last sheet sent to press. (2) That authors' separate copies should be issued with the original pagination and plate-numbers clearly indicated on each page and plate, and with a reference to the original place of publication. (3) That authors' separate copies should not be distributed privately before the paper has been published in the regular manner. The Committee, however, observes that these customs are by no means universal, and asks that they shall be more generally put into force. The Committee further asks for co-operation in the following matter. There are certain rules of conduct upon which the best workers are agreed, but which it is impossible to enforce, and to which it is difficult to convert the mass of writers. These are: (4) That it is desirable to express the subject of one's paper in its title, while keeping the title as concise as possible. (5) That new species should be properly diagnosed and figured when possible. (6) That new names should not be proposed in irrelevant foot-notes, or anonymous paragraphs. (7) That references to previous publications should be made fully and correctly, if possible in accordance with one of the recognised sets of rules for quotation, such as that recently adopted by the French Zoological Society. The Committee points out that these and similar matters are wholly within the control of editors (*rédaction*) and publishing committees, and any assistance in putting them into effect will be valued, not merely by the Committee, but, it is believed, by zoologists in general. Any remarks on the above matters may be addressed to Mr. F. A. Bather, Secretary of the Committee, at the Natural History Museum, Cromwell Road, London, S.W.

AN account of experiments, conducted by G. W. and E. G. Peckham, for testing (1) the range of vision and (2) the colour-sense of spiders, published in a late volume of the *Transactions*

of the Wisconsin Academy, is given in the *American Naturalist*. The evidence offered by the authors is based upon a study of twenty species of Attidæ. This study extended over eight successive summers, during which notes were made of many hundreds of observations. The movements and attitudes of the spiders of the group chosen are wonderfully vivid and expressive. The males, in the mating season, throw themselves into one position when they catch sight of a female, and into quite another at the appearance of another male. This power of expression through different attitudes and movements was of great assistance in determining not only its range of sight, but also its power of distinct vision. The results of these experiments are summed up as follows:—"The Attidæ see their prey (which consists of small insects) when it is motionless, at the distance of five inches; they see insects in motion at much greater distances; they see each other distinctly up to at least twelve inches. The observations on blinded spiders, and the numerous instances in which spiders were close together, and yet out of sight of each other, showing that they were unconscious of each other's presence, render any other explanation of their action unsatisfactory. Sight guides them, not smell."

We learn from *Science* that the U.S. Weather Bureau has issued what it calls a "souvenir" map of the St. Louis tornado of May 27. On one side there is a map showing the weather conditions over the United States on the evening of that day, with the tornado districts indicated by red crosses, and with a brief descriptive text beneath. On the reverse side is an explanation of the wind, weather, and temperature signals of the Bureau.

The Pilot Chart of the North Atlantic Ocean for the month of August shows the probable routes followed by eighty-two bottle-papers thrown from vessels and returned to the U.S. Hydrographic Office between December 1, 1895, and June 1, 1896. Some of the individual drifts are very noteworthy, but the general course of the bottles clearly illustrates the two main features of the general surface circulation of the waters of the North Atlantic: (1) a vast but gentle eddy extending from the equator to the parallel of 48° N., and completely enclosing that portion of the ocean lying between the trades and the anti-trades, in which the currents are feeble in force and variable in direction; and (2) the so-called extension of the Gulf Stream, which proceeds north-eastward and skirts the shores of Iceland on the one hand, and Scotland and Norway on the other. The principal meteorological feature during July was the large areas of fog reported. Several westward-bound vessels met the fog near 25° W., and, with the exception of short intervals, did not have clear weather again till reaching the American coast.

Referring to M. Marmier's paper on the action of currents of high frequency on microbic poisons (noticed in Nature for July 30), Dr. d'Arsonval writes to the *Société Française de Physique* pointing out, in the first place, that he has succeeded in attenuating poisons when frozen, and, in the second place, that he has destroyed the virulence of the venom of the cobra snake by means of currents of high frequency at a temperature not exceeding 40°, although, according to MM. Phisalix and Bertrand, this venom does not ordinarily lose its virulence till it has been heated to 150° in sealed tubes. Dr. d'Arsonval has been led to the conclusion that the action is not due to any heating effects, but is rather of an electrolytic nature. It is not here a matter of ordinary electrolysis with liberation of chemical constituents in the neighbourhood of the electrodes, but rather a series of alternating decompositions and recombinations following each other in rapid succession from molecule to molecule without giving rise to any free products.

The goats of Anatolia seem to be remarkable for their susceptibility to a particular form of pneumonia which, although in some respects resembling the pleuro-pneumonia to which calves are addicted, is yet quite distinct in its microbic origin. M. Nicole, formerly assistant at the Pasteur Institute in Paris, and now director of the Imperial Bacteriological Institute in Constantinople, has made a careful study of this disease, in conjunction with one of his assistants, Réfik-Bey. Constantly associated with the disease the authors have found a bacillococcus which, as its name indicates, is polymorphic in appearance, and might by some be regarded as belonging to a group of micro-organisms known under the collective title of the "bacteria of hæmorrhagic septicæmia," of which the fowl-cholera microbe is usually taken as the type. This group owes its origin to a hypothesis of MM. Nocarde and Leclainche, who regard the various organisms associated with hæmorrhagic septicæmia as mere variations from one parent form, the ovoid bacterium. This hypothesis, although attractive, requires further experimental confirmation before it can be unhesitatingly accepted; and M. Nicole considers that he has shown by his investigations that the organism which he has discovered to be the pathological agent in this pneumonia affection of Anatolian goats, is entirely distinct from that associated with the closely-allied pneumonic disease to which calves are subject.

A great deal has been written about the difficulties surrounding the production of diphtheria toxines of efficient strength in a reasonable space of time. Some investigators have stated that an abundant supply of air is essential in the culture flasks, and specially constructed vessels admitting a current of air have been devised; others, again, assert that meat which has almost commenced to putrify is far more effective than fresh meat. M. Nicole, however, now tells us, in a recent number of the *Annales de l'Institut Pasteur*, that he can procure a powerful toxine in the simplest and briefest possible manner by employing the juice of beef only a few hours after it has been killed, with addition of peptone and salt, the whole being brought to the boiling-point, then filtered, rendered strongly alkaline, and heated for ten minutes at 120° C. After being again filtered, it is distributed in any sort of vessel which may be to hand, and sterilised by being subjected for a quarter of an hour to a temperature of 115° C. The diphtheria microbe is introduced, and the cultures are kept for five days at 37° C., when a toxine of high toxic quality is ready for use. This simple process ought to recommend itself to all who have the preparation of diphtheria toxines to superintend, for M. Nicole tells us that the results he has obtained have never failed, but, on the contrary, have been absolutely constant.

A letter from Messrs. P. and F. Sarasin to the Freiherr von Richthofen, announcing their return from an exploration of the south-east arm of Celebes, is published in the *Verhandlungen der Gesellschaft für Erdkunde zu Berlin*. The explorers report the examination of two lakes hitherto almost unknown to Europeans, the Lakes Matanna and Towuti. These lakes lie in an S-shaped depression between two ranges of mountains. Lake Matanna is of great depth, a sounding in the middle giving 480 metres without bottom. Remains of a prehistoric village built on piles, and now submerged, were discovered, many of the bronze and pottery articles found being very similar to those obtained in such villages in Europe. The surface of Lake Matanna is about 400 metres above sea-level, that of Lake Towuti about 350 metres.

Prof. Dr. Karl Futterer contributes to the *Verhandlungen der Gesellschaft für Erdkunde zu Berlin* an extremely interesting paper containing a detailed comparison of the Ural and Caucasus Mountains. Discussing the similar origin of the

two ranges, and the similarity of conditions affecting the Caucasus and the southern Urals, the various progressive stages of erosive action are carefully traced, and the results taken to illustrate a number of important points in the new science of geomorphology, especially in connection with such examples as the Alleghany Mountains, and the extinct range known to geologists as the "Central German Alps," which now forms the Thuringian and Black Forests, and the Harz.

THE Geodynamic Section of the Meteorological Observatory of Constantinople has just completed the publication of its first year's work, and in the last monthly *Bulletin* (for December 1895) the Director, Dr. Agamennone, summarises the results. The area studied is not confined to the Ottoman Empire, but includes all the countries bordering the eastern end of the Mediterranean. Nevertheless, out of 753 shocks recorded in the *Bulletins* (an average of more than two per day), 400 belong to Turkey; while 236 occurred in Greece, and 55 in Bulgaria. Of the Greek earthquakes, more than two-thirds were felt in the island of Zante. From Persia, the Caucasus, and the region beyond the Caspian Sea, the reports are few in number, but this is probably owing to the want of observers. The slight shocks of course greatly predominate, amounting to 519; 225 were strong, or very strong, and nine disastrous. Most of the records are very brief, but more detailed accounts are given of four earthquakes—those of the Caspian Sea on July 9, the Adriatic Sea on August 9, Pergama on November 13–14, and Salonica on December 2. The value of Dr. Agamennone's work will be evident when we compare this ample chronicle with the list of 49 shocks in the Ottoman Empire during the previous year.

THE difficulty of recognising the direction from which a sound proceeds is a well-known obstacle to the full utilisation of acoustic signals at sea. It often happens that a gun signal, or especially a steam whistle, is supposed by one of the watch to be on the port side, while another hears it to starboard. M. E. Hardy, in *La Nature*, describes an apparatus which should prove effective for determining the direction of the sound waves. Two microphones are placed on board at as large a distance apart as possible, say 100 yards. Each of the microphones is connected with a telephone. The observer holds the forward telephone to his right ear, and the stern telephone to his left. Then, when a signal is given by a vessel straight ahead, he will hear it first in his right ear and then in his left, and the interval will be that required by the sound wave to travel from one microphone to the other. In the case supposed, the interval will be about one-third of a second. When the strange vessel is just abeam, the sounds will strike the microphones at the same instant, and the observer will hear them as coincident. When it is just astern, the left ear will be the first to hear the signal. This method, while capable of fixing the angle between the keel of the vessel and the direction of the stranger, does not decide the port-or-starboard question. This might be done by a similar auxiliary apparatus amidships. Another method described by the same author is based upon the interference of sound waves, the sound being received by a tube dividing into two branches whose ends are placed at a distance apart equal to half the length of the sound wave, and are attached to the ends of a bar capable of rotating in a horizontal plane. When this bar points in the direction whence the wave proceeds, and only then, will the sound heard through the tube vanish by interference. But the wave may be proceeding along the bar either forwards or backwards, so that here again we have an ambiguity. But it must be borne in mind that the choice between two exactly opposite directions is comparatively easy. Considering the differences of pitch of the various bells, whistles, and fog-horns in use, we should prefer the first method. But the sound rays rarely proceed in straight lines from the source, and there are many objective difficulties besides the subjective one mentioned.

IN the May number of the *Records* of the Indian N.W. Geological Survey, Dr. W. T. Blanford sums up the results of recent investigations on the ancient geography of Gondwána-land, the great southern continent of which Australia, peninsular India, Southern Africa and South America are the now isolated remnants. He points out how, one by one, each of these great southern land-masses has been found to contain remains of the peculiar Gondwána flora so different from the contemporaneous (Carboniferous and early Mesozoic) floras of the northern hemisphere, and how in each case a peculiar boulder-bed, accompanied by unquestionable evidence of its glacial origin, has been found associated with them. Recent discoveries in South America have completed the chain of resemblance, and show the great extent of the Gondwána continent. At the same time, if the South American boulder-bed be as truly glacial as that of the other areas, any attempt to explain the occurrence of this glaciation within the Tropics by a shifting of the earth's axis must be finally abandoned. It does not necessarily follow that an unbroken continental tract extended at one and the same time from South America through Africa and India to Australia, but the whole region must at least have been mainly land, at a time when the Pacific Ocean was already as important a terrestrial feature as it is now. This continental mass, too, with its peculiar flora, must have been separated from the northern lands, on which the *Lepidodendron* and *Sigillaria* of our coal-measures flourished, by some barrier, probably the Tethyan Ocean of Suess, of which our present Mediterranean and Caribbean seas are the shrunken remnants. Two recently recorded facts of hydrography are mentioned by Dr. Blanford, as throwing an interesting side-light on the difference now existing between the ancient basin of the Pacific and the modern oceans which occupy part of the site of Gondwána-land. The first is the much slower rate at which the Krakatoa wave of 1883 was propagated through the shallower waters of the South Atlantic than through the deep Pacific. The other is the warm temperature of the bottom-waters of the North-west Indian Ocean, which indicates that they (like those of the Mediterranean) are isolated by some barrier from the cold bottom-currents, and such a barrier must run in precisely the direction required for the ancient connection of India and Southern Africa. Thus evidence from all directions converges to indicate the fundamental difference between Atlantic and Pacific Oceans, and in this, bound up as it is with the history of Gondwána-land, it may well be that the key to many a geological puzzle will yet be found.

THE second and concluding part of Mr. C. D. Sherborn's *Index to the Genera and Species of the Foraminifera* (NON—Z) has been published by the Smithsonian Institution. It shows signs of the most scrupulous care in preparation, and should prove a boon to future workers on the Foraminifera.

THE Jubilee of the Chemical Society of London was celebrated in 1891, and it formed the subject of articles in these columns at the time. A record of the proceedings, together with an account of the history and development of the Society, has now been published in a souvenir volume. Translations are given of the addresses sent by foreign societies, and of the speeches made by the foreign delegates. A translation is also given of M. Dumas' Faraday lecture, as well as abstracts of the five other Faraday lectures. The Society boasts of being the first which was formed solely for the study of chemistry, and success has attended it from its foundation. It soon became a centre of the chemical life of this country, and by its publications it has played the chief part in the advancement of chemistry. The volume

just published will make Fellows of the Society proud of their Fellowship, and will arouse a spirit of emulation among chemists in many parts of the world.

STUDENTS of meteorology will be glad to know that three important essays on Australian weather have, by the generosity of the Hon. Ralph Abercromby, been brought together and published in book form. The first essay, on "Moving Anticyclones in the Southern Hemisphere," by Mr. H. C. Russell, F.R.S., was originally read before the Royal Meteorological Society, and published in the Society's *Journal*. The leading fact brought out in this paper is that Australian weather south of lat. 20° S. is the product of a series of rapidly moving anticyclones, which follow one another with remarkable regularity, and are the great controlling force in determining local weather. These anticyclones travel eastward at the average rate of four hundred miles per day, and they do so with such regularity that the prospect is held out of weather predictions being made some weeks in advance, or even for longer periods. The second essay in the volume is the one, by Mr. H. A. Hunt, on "Southerly Bursters," which won the prize offered by the Hon. Ralph Abercromby. This essay was noted in NATURE in January 1895 (vol. li. p. 230). The third essay, which is also by Mr. Hunt, has for its subject "Types of Australian Weather." This discussion throws much new light upon the source of the greater part of Australian rain, and at the same time forms an important contribution to the study of weather in the southern hemisphere generally. The volume containing these essays is published by Mr. F. W. White, Sydney.

THE additions to the Zoological Society's Gardens during the past week include four Malabar Squirrels (*Sciurus maximus*) from Southern India, presented by Mr. W. J. Stillman; two Sclater's Curassows (*Crax sclateri*) from Minas Geraes (Brazil), presented by Mr. E. Sumead; a Temminck's Stint (*Tringa temmincki*), British, presented by Mr. E. C. Sprawson; a Golden Eagle (*Aquila chrysaetus*) from Spain, presented by Mr. F. Leathly Holt; three Common Blue-birds (*Sialia wilsonii*) from North America, presented by Mr. A. T. Binny; two Stone Curlews (*Œdicnemus scolopax*), British, presented by Mr. W. J. Kidman; two Common Blue-birds (*Sialia wilsonii*) from North America, presented by Mr. Percy Cockshut; three Common Adders (*Vipera berus*), British, presented by Mr. A. Old; three Peruvian Snakes (*Tachymenis peruviana*) from Peru, presented by Mr. A. H. Jamrach; a White-browed Amazon (*Chrysotis albifrons*) from Honduras, purchased; a Wapiti Deer (*Cervus canadensis*, ♀), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

LUNAR PHOTOGRAPHS.—Prof. Weinek, whose artistic skill in the enlargement of lunar photographs cannot but be admired, and who has co operated with the staff of the Lick Observatory in reproducing from their negatives the more interesting features of the moon, has recently made a further contribution to the Vienna Academy of fifteen enlargements of certain details on the lunar surface, as seen at the third quarter. Also, Aristarchus and Herodotus have been drawn with the shadows thrown on the western side as a companion picture to an earlier enlargement in which the shadows are thrown to the east. Dr. Weinek now takes the opportunity of calling attention to the fact that, in many instances, his drawings, indicating the existence of minute detail, have been confirmed by Dr. Gaudibert from optical examination of the moon itself. This remark refers to drawings from original negatives taken both at the Lick and Paris Observatories. The differences between the photographic reproductions and Schmidt's map are admitted, and according to the description furnished by Dr. Gaudibert, it is a little difficult to explain some of the omissions from this well-known authority.

DISTRIBUTION OF BINARY-STAR ORBITS.—Miss Everett gives in *Monthly Notices*, June 1896, pp. 462-466, the results of an attempt to discover if the planes of the orbits of binary stars have any relation to the plane of the Milky Way. To do this, the most accurate values of the elements of fifty-five orbits were taken, and from these the galactic longitudes and latitudes of the poles of the orbits were calculated and tabulated. Gould's value of the position of the galactic northern pole was assumed, viz. R.A. 12h. 42m. 4s. (190° 31′), Decl. +27° 16′ (Epoch 1890). This gives the obliquity of the central line of the Galaxy as 62° 7′, and the position of the ascending node is at R.A. = 18h. 42m. (280° 31′), from which the galactic longitudes are reckoned. On examining the tables, it appears that equal surface zones contain nearly similar numbers of orbit poles, and it is concluded that there is no decided tendency on the part of the poles of the orbits to favour any special region of the celestial sphere, and hence that the planes of the orbits cannot be regarded as having any definite relation to the mean plane of the Galaxy.

COMET 1890 VII.—The orbit of this comet, which was first seen by Dr. Spitaler of Vienna, while searching for one recently discovered by M. Zona of Palermo, has been submitted to a thorough examination by the original discoverer, with the result that the period of six and half years has been confirmed. Consequently, its return to perihelion may be looked for next spring, and Dr. Spitaler has prepared ephemerides to facilitate its search. The most favourable time for observation will be next month, when the comet will be in opposition, but the theoretical brilliancy will be only about one-fourth that possessed at the time of discovery in 1890. The considerable southern declination of the comet will render its detection in these latitudes still more difficult. The next return in 1903 will be still more unfavourable, and though 1909 may offer good chances for observation, the error of position will be larger. Dr. Spitaler thinks that the ephemeris he has prepared for this return is trustworthy to about five minutes of R.A. and forty minutes of Declination.

PHOTOGRAPHY OF SOLAR CORONA.—Count de la Baume Pluvinel has recently discussed the conditions necessary for successfully obtaining photographs of the corona (*Bulletin de la Soc. Ast. de France*, July 1896). The difficulty of the problem lies in the varying intensity of the several parts of the corona, the delicate details being lost in long exposures on the inner region, while in short exposures the outer corona is almost absent. During the eclipse of April 1893, the author attempted to determine the best value of the "photographic action" necessary for depicting the coronal structure without allowing the light from the surrounding sky to produce any deteriorating effect. The term "photographic action" is defined as being proportional to the product of the intensity of the image and the duration of exposure, and is accepted as being constant within certain limits. For this purpose he employed a compound camera having nine object-glasses, with apertures varying from 5 mm. to 155 mm., and average focal length of 1·5 metres. The time of exposure for all was 230 secs., and consequently the photographic action had values varying from 0·24 to 250. From the various photographs obtained he concluded that, for that particular climate (Joal) a photographic action of about 4 was best. From other photographs taken in Brazil, he recommends a value of 10 to be used in future eclipses, this value to be diminished or augmented as the sky light is greater or less than that in 1893. The above law of photographic action ceases to hold beyond certain limits; as the intensity of the light decreases, the time of exposure must be enormously increased, and this fact has led the author to suggest a method of photographing the corona without an eclipse. It involves the design of a telescope with such a ratio between aperture and focal length that the sky illumination will be too feeble to affect the plate, while the slightly greater intensity of the corona will allow of its being photographed with a long exposure.

NANSEN'S POLAR EXPEDITION.

DR. NANSEN arrived at Vardö, Norway, on Thursday, August 13, after an absence of three years. A Reuter telegram says that he left the *Fram* with a companion on March 14, 1895, in lat. 84° N., in order to push further north into the Polar Sea than the *Fram* could penetrate. The expedition accomplished its object in traversing the Polar Sea to a point north of the New Siberia islands. The most northerly

point attained was lat. 86° 14', which is nearly 200 miles further north than had previously been reached. No land was sighted north of 82°. Dr. Nansen and his companion then went south to Franz Josef Land, where they passed the winter, subsisting on bears' flesh and whale blubber. Here they fell in with the *Windward*, of the Jackson-Harmsworth expedition, which brought them to Vardö. It is expected that the *Fram* will eventually arrive at Spitbergen.

With most commendable enterprise, the *Daily Chronicle* published on Saturday, August 15, Dr. Nansen's own narrative of his expedition, telegraphed from Vardö. The narrative is in the highest degree interesting, as well as a striking testimony to the hardihood and indomitable spirit of Dr. Nansen and Lieut. Johansen, who for seventeen months, cut off from all means of retreat, travelled over nearly 700 miles and carried on polar explorations. The telegram published in the *Daily Chronicle* is abridged below; and we are glad to express our acknowledgments to that newspaper for the opportunity afforded us of placing before the readers of NATURE the salient points in this account of Dr. Nansen's explorations of polar regions.

The *Fram* left Jugor Strait August 4, 1893. We had to force our way through much ice along the Siberian coast. We discovered an island in the Kara Sea, and a great number of islands along the coast to Cape Cheljuskin. In several places we found evidences of a glacial epoch, during which Northern Siberia must have been covered by inland ice to a great extent.

On September 15 we were off the mouth of Olenek River, but thought it too late to go in there to fetch our dogs, as we would not risk losing a year. We passed the New Siberian Islands on September 18.

On September 22 we made fast to a floe in latitude 78° 50' N., and longitude 133 37' E., and allowed the ship to be closed in by the ice.

As anticipated, we were gradually drifted north and north-westward. The sea was up to ninety fathoms deep south of 19° N., where the depth suddenly increased, and was from 1600 to 1900 fathoms north of that latitude. This will necessarily upset all previous theories based on a shallow Polar Basin. The sea-bottom was remarkably devoid of organic matter. During the whole drift I had good opportunities to take a series of scientific observations—meteorological, magnetic, astronomical, biological soundings, deep-sea temperatures, examinations for salinity of the sea-water, &c. Under the stratum of cold ice-water covering the surface of the Polar Basin, I soon discovered the warmer and more saline water due to the Gulf Stream, with temperatures from 31° to 33°. We saw no land, and no open water, except narrow cracks, in any direction.

As anticipated, our drift north-westward was most rapid during the winter and spring, while northerly winds stopped or drifted us backwards during the summer. On June 18, 1894, we were on 81° 52' N. lat., but drifted then southward only. On October 21 we passed 82°. On Christmas Eve, 1894, latitude 83° N. was reached, and a few days later 83° 24', the farthest north latitude previously reached by man.

As I anticipated that the *Fram* would soon reach her highest latitude to the north of Franz Josef Land, and that she could not easily fail to carry out the programme of the expedition, viz. to cross the unknown Polar Basin, I decided to leave the ship in order to explore the sea north of her route. Lieut. Johansen accompanied me. On March 3 we reached 84° 4' N. Johansen and I left the *Fram* on March 14, 1895, at 83° 59' N. lat., and 102° 27' longitude East of Greenwich. Our purpose was to explore the sea to the north, reach the highest latitude possible, and then go to Spitzbergen *viâ* Franz Josef Land, where we were certain to find a ship.

On March 22 we were on 83° 10' N. lat. The ice now became rougher, and the drift contrary. On April 3 we were at 85° 50' N., constantly hoping to meet with smoother ice. On April 4 we reached 86° 3' N., but the ice became rougher, until on April 7 it got so bad that I considered it unwise to continue our march in a northerly direction. We were then at lat. 86° 14' N.

I then made an excursion on *ski* further northward in order to examine the possibility of further advance, but I could see nothing but ice of the same description, hummock beyond hummock to the horizon, looking like a sea of frozen breakers, the whole time. We had had a low temperature during nearly three weeks: it was in the neighbourhood of 40° below zero. On April 1 it rose to 8° below, but soon sank again to 38°. The minimum in March was 49° and the maximum 24°. In April the minimum was 38° and the maximum 20°.

On April 8 we began our march towards Franz Josef Land. On April 12 our watches ran down, and we were after that date uncertain of our longitude, but hoped that our dead reckoning was fairly correct. We expected daily to find land in sight, but we looked in vain.

On May 31 we were in 82° 21' N.; on June 4 in 82° 18' N.; but on June 15 we had been drifted north-west to 82° 26'. No land was to be seen, although, according to Payer's map, we had expected to meet with Petermann Land at 83° N. These discrepancies became more and more puzzling as time went on.

We did not reach land until August 6, at 81° 38' N. lat. and about 63° E. long. This proved to be entirely ice-capped islands. In our "kayaks" we made our way westward in open water along these islands.

On August 12 we discovered land extending from south-east to north-west. The country became more and more puzzling, as I could find no agreement with Payer's map. I thought we were in a longitude east of Austria Sound; but if this were correct, we were now travelling straight across Wilczek Land and Dove Glacier, without seeing any land near us.

On August 26 we reached a spot in 81° 13' N. and 56° E., where we wintered. The spring came with sunshine and much open water to the south-west, and we hoped to have an easy voyage to Spitzbergen over floe ice and open water. On May 19 we were at last ready to start, and came to open water on May 23, in 81° 5' N., but we were retarded by storms until June 3. A little south of 81° we found land extending westward, and the open water reached west-north-west along its north coast. But we preferred to travel southward over ice through a broad Sound. We came on June 12 to the south side of the islands, and found much open water, trending westward. We sailed and paddled in this direction in order to proceed across to Spitzbergen from the most western cape, but Payer's map is misleading.

We left Franz Josef Land in the *Windward* on August 7, and had a short and very pleasant passage, thanks to the masterly way in which Captain Brown brought his ship through the ice, and thence in the open sea to Vardö.

BACTERIA AND CARBONATED WATERS.

THE new methods of bacteriological research were early called into requisition to determine what hygienic importance from a bacterial point of view could be ascribed to the gaseous aëration of water.

A large number of experiments have from time to time been carried out, and various points of interest have been investigated, but nevertheless considerable divergence of opinion exists as to the precise hygienic value with which the carbonation of water can be credited.

Some authorities state that in such waters the number of bacteria steadily declines, whilst others again have observed as distinct a multiplication of the bacteria present.

The possibility of these two contingencies is, however, quite conceivable without necessarily impugning the accuracy of the results obtained in either case. In the first place it must be remembered that widely different types of water serve for the manufacture of artificial aërated waters, the bacterial contents of which are likewise widely divergent both qualitatively and quantitatively.

Here, then, in the first instance is a source of discrepancy, for the behaviour of bacteria in carbonated waters, as also under other conditions, primarily depends upon the particular varieties of bacteria which have to be dealt with.

It has been shown that whereas some bacteria rapidly disappear in aërated waters, others again are endowed with fabulous powers of multiplication and longevity.

Thus in one instance a sample of carbonated water was found to contain, one hour after its manufacture, 8350 microbes per cubic centimetre; these figures rose, however, after the lapse of 210 days, to the considerable number of 212,400 per c.c.; later on, however, at the end of 428 days, there were only 46 per c.c.

Again, as regards the duration of vitality of ordinary water microbes under these circumstances, we read of as many as 91 being found per c.c. in a sample of water which was considerably more than two years old.

It is obvious, therefore, that as regards the bacterial contents

of a particular sample of aërated water, the results are in the first instance dependent upon the bacterial quality of the original water employed, and the nature of the particular microbes present, whilst it must be acknowledged that a considerable element of chance is introduced into the results, inasmuch as they so greatly depend upon the time at which the examination happens to be made

Thus in the above example, where such enormous multiplication was observed, no one would hesitate, on the strength of such figures, to condemn that water from a bacterial point of view, whilst if its examination had been longer postponed until it yielded only 46 microbes per c.c., as unhesitating a favourable verdict might have been pronounced upon it. As regards the influence of the bacterial purity of the original water upon the finished article, we have frequent evidence of the paucity of bacteria present when the raw water employed has been deprived of all microbial life by boiling or distillation; but even when such precautions are taken in the first instance, we often find that very considerable numbers of bacteria are present in this water after aëration, a fact which is to be ascribed to the bacterial contamination which subsequently obtains in the process of manufacture. Such contamination may be due to various causes; the storage of the water in reservoirs in the factory has been shown in some cases to be responsible for this result, whilst Dr. Abba has recently called attention to the condition of the bottle-syphons used for the distribution of aërated waters as frequently contributing to bring about this condition of things.

These syphons, he states, in his important report on the aërated waters supplied to Turin, are not only left unsterilised after use, but they are neither washed out nor even emptied completely; hence a deposit is always present, which furnishes ample material for the bacterial contamination of the freshly added water. Another factor which controls to a certain extent the bacterial contents of aërated waters is the amount of carbonic anhydride which is present. This point has been well illustrated by Slater, and Dr. Abba has confirmed his results. Thus:

Amount of carbonic anhydride present per litre. (Grammes.)	Bacteria per c.c.
15·08	299
12·10	388
11·74	435
9·07	1207
8·01	1354
6·90	1580
6·03	2032

Whether the above rise in the bacterial contents on the release of the gas present is due to the diminution of the pressure or to the specific action of the gas being modified, it is difficult to say; probably both causes co-operate in bringing about the result. At present we have no authoritative experimental observations to decide this point.

That carbonic anhydride is capable of exercising very specific action in the case of some micro-organisms in the absence of pressure, was shown some years ago by Dr. Percy Frankland in his experiments on the influence of carbonic anhydride and other gases on the development of micro-organisms (*Proc. Roy. Soc.*, 1889). Three microbes were experimented with—Koch's cholera bacillus, Finkler-Prior's bacillus, and the *Bacillus pyocyaneus*, an organism frequently found in green pus.

These bacteria were exposed on gelatine surfaces to the action of the gas in closed vessels, and after a time they were transferred to vessels containing air only.

In the case of Koch's bacillus and Finkler-Prior's bacillus, no growth whatever appeared in the carbonic anhydride vessel, neither did any sign of vitality make its appearance when the bacilli in question were subsequently transferred to the air vessel.

The case was, however, different with the green-pus bacillus, for although no growths appeared in the presence of the gas, on being removed to the air-vessel, growths did manifest themselves, showing that the carbonic anhydride had not succeeded in destroying the bacilli as it had done the two others.

Here, then, we have an example of the specific action of the gas being controlled by the character of the particular microbe to be dealt with. Some authorities ascribe the action of carbonic anhydride simply to the bacteria being deprived of oxygen by its means, but the absence of oxygen can also not be held entirely responsible for the deleterious action of carbonic anhydride; thus, in an atmosphere deprived of oxygen by means of hydrogen, Dr. Percy Frankland found that the growth of Koch's cholera bacillus was not interfered with at all, but we have seen how fatally it was affected in the absence of oxygen by the carbonic anhydride. Here, then, clearly the presence or absence of oxygen would appear to have no voice in the results obtained.

As regards the behaviour of pathogenic bacteria in carbonated waters, the results so far obtained are decidedly more unanimous.

There is no doubt that a very general impression prevails that a barrier of no mean obstructive power is placed between the consumer and zymotic disease, by the substitution of aerated waters for ordinary drinking-water, at any rate during times of epidemics.

This impression is to a certain extent justified by investigation, but can at the same time only be encouraged to a moderate extent, as the following researches will sufficiently show.

When anthrax bacilli are introduced into ordinary seltzer water, they do not live more than from fifteen minutes to one hour; when the spores, however, are similarly treated, they survive upwards of 154 days.

As, however, anthrax in the condition of bacilli devoid of spores is only very exceptionally met with, we cannot derive much comfort from using seltzer water; fortunately, however, so far the communication of anthrax is not associated with drinking-water, and from a hygienic point of view the above results may be regarded as of, perhaps, more theoretical than practical interest.

Our position with reference to cholera germs and water is, however, on quite a different footing, and it is extremely reassuring to learn, on the authority of such investigators as Hochstetter, Slater, and Abba, that in ordinary seltzer and soda water, cholera bacilli cannot live longer than three hours. Dr. Abba records some curious results, in which he states that in *sterilised* tap-water gaseously aerated cholera bacilli persisted as long as forty-eight hours, whilst if such sterilised aerated water is rendered alkaline by the addition of 1 per 1000 bicarbonate of soda, their life was prolonged for as much as twelve days.

It would appear that sterilisation, or the removal of competing water bacteria, materially assisted the life of cholera bacilli; and this impression is confirmed by another experiment with alkalised water, in which the water was not sterilised first, and in which the vitality of the bacilli, instead of reaching twelve, was cut down to seven days.

Unfortunately, as regards typhoid infected water, we cannot resort with any degree of security to carbonated waters, unless we have proof that the manufactured article has been stored for at least a fortnight before use.

Slater observed typhoid bacilli alive in ordinary aërated water as long as eleven days, and both Abba and Hochstetter record a vitality of five days. In some cases, however, they appear to disappear much more rapidly, and doubtless a great deal depends upon the initial vital condition of the particular cultivation of typhoid bacilli employed.

Here again Dr. Abba finds in *sterilised*, alkalised, aerated water, that the persistence of the typhoid bacilli is superior to that observed in similar waters not deprived of their bacterial life.

Dr. Abba has also experimented in a similar manner with the *B. coli communis*, and finds that, beyond its exhibiting the customary character of superior hardiness under adverse circumstances to its near relative, the typhoid bacillus, its behaviour resembled that of the latter. Although storage even for such considerable periods of time as over two years cannot, as we have seen—at any rate in some cases—secure the entire elimination of ordinary water microbes, yet storage of considerably shorter duration is of undoubted service in the destruction of disease germs, as far as our information at present goes.

It would appear reasonable, therefore, to make a practice of storing such waters before distribution, a measure recommended many years ago by Duclaux, and which, in the absence of preliminary precautions, such as the removal of all bacteria present by boiling, distillation or efficient filtration, would appear to be a measure of great hygienic importance.

G. C. FRANKLAND.

A NEW OXYACID OF NITROGEN.

ALTHOUGH rapid strides have been made recently in the chemistry of nitrogen and its inorganic derivatives, since the discovery of hyponitrous acid by Dr. Divers in 1871, no new oxyacid of nitrogen has been described. In the current number of the *Gazzetta Chimica Italiana* (July 31), there is an account by Dr. A. Angeli of the preparation and properties of the sodium and barium salts of a new acid, $H_2N_2O_3$, which fills the gap between hyponitrous and nitrous acids. The method of obtaining this acid is simple and elegant. An alcoholic solution of free hydroxylamine is prepared in the usual manner from hydroxylamine hydrochloride and sodium ethylate, an excess of the latter being taken, and to the solution after filtering off the precipitated salt is cautiously added the theoretical quantity of ethyl nitrate. The reaction proceeds according to the equation $C_2H_5.ONO_2 + NH_2OH = C_2H_5.OH + H_2N_2O_3$, the white sodium salt of the new acid commencing to separate out at once. From this salt, which on analysis proved to be $Na_2N_2O_3$, the barium salt is readily obtained in a pure state by adding barium chloride to the dilute aqueous solution. These salts are both moderately stable in the dry state, but are easily decomposed, on boiling the aqueous solution, into the hydrate of the metal and nitric oxide. The same gas is given off quantitatively on acidifying the aqueous solution, and hence all attempts to isolate the free acid have failed. As regards the composition of this acid, from its mode of formation, the formula $(NO_2)NH.OH$, or nitro-hydroxylamine, naturally follows; and this is to some extent confirmed by the fact that the yellow silver salt, momentarily obtainable from the aqueous solution, is reduced in a few seconds to metallic silver, and Fehling's solution is also readily reduced. The existence of an acid of this composition has already been indicated by Dr. A. Thum, who showed that hydroxylamine salts when oxidised by potassium permanganate in hot alkaline solution take up exactly as much oxygen as corresponds to the formation of $Na_2N_2O_3$, the formula of which might be $O\left\langle\begin{array}{l}N.ONa\\|\\N.ONa\end{array}\right.$. This salt, not yet isolated, is clearly isomeric with the sodium salt above described, since it suffers no further oxidation on boiling with excess of potassium permanganate. It would also yield only one ethyl derivative, whilst nitro-hydroxylamine might be expected to give the isomers $(NO_2).NEt.(OH)$ and $(NO_2).NH.OEt$, which would be readily distinguishable, and this point is being followed up by Dr. Angeli. He has also applied the same reaction to amyl nitrite and to nitrobenzene (*Berichte*, July 27). The amyl nitrite formed a sodium salt, the aqueous solution of which gave a yellow silver salt resembling silver hyponitrite. Nitrobenzene gave a substance which is probably $C_6H_5.NO : N(OH)$, identical with the nitroso-phenylhydroxylamine, $C_6H_5.N(NO).OH$ of Bamberger. The further development of this work, which may be expected to throw light on the constitution of Traube's isonitramine derivatives, Frankland's dinitroethylic acid, and of Pelouze's salt, will be looked for with much interest.

G. N. H.

A RESEARCH ON THE LIQUEFACTION OF HELIUM.[1]

MY experiments on the liquefaction of helium were carried out with a sample of that gas, sent to me by Prof. Ramsay from London, in a sealed glass tube holding about 140 ccm. I take this opportunity of rendering him my most sincere thanks. In his letter Prof Ramsay informed me that the gas had been obtained from the mineral clèvite, and that it was quite free from nitrogen and other impurities, which could be removed by circulation over red-hot magnesium, oxide of copper, soda-lime, and pentoxide of phosphorus. The density of the gas was 2·133 and the ratio of its specific heats (Cp/Cv) 1·652; the latter figure indicating that the molecule of helium was monatomic, as had already been found to be the case with argon.

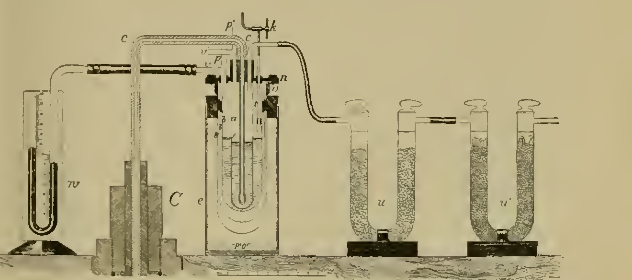
[1] Translated from the original paper, by Prof. K. Olszewski, in the *Bulletin de l'Académie des Sciences de Cracovie* for June 1896, "Ein Versuch, das Helium zu verflünigen," by Morris Travers.

Prof. Ramsay further informed me that the gas was only very slightly soluble in water; 100 ccm. of water dissolving scarcely 0·7 ccm. of helium.

From the results of my earlier experiments I had been led to expect that it would be only possible to liquefy helium at a very low temperature; the small values obtained for the density and solubility of the gas, together with the fact that its molecule is monatomic, indicating a very low boiling-point. For this reason I did not consider it necessary to use liquid ethylene as a preliminary cooling agent, but proceeded directly to conduct my experiments at the lowest temperature that could be produced by means of liquid air. The apparatus employed in these investigations is figured in the accompanying diagram.

The helium was contained in the glass tube, *c*, of the Cailletet's apparatus, C. The tube, *c*, reached to the bottom of a glass vessel, *a*, which was intended to contain the liquid air. The vessel, *a*, was surrounded by three glass cylinders, *b*, *b′*, and *b″*, closed at the bottom and separated from one another. The outer vessel, *b″*, was made just large enough to fit into the brass collar, *o*, which supported the lid, *n*, of the apparatus. The tube, *a*, fitted into an opening in the centre of the lid; the tube, *t*, connected with an apparatus delivering liquid oxygen, passed through a hole on the right. The vessel, *b*, was also connected with a mercury manometer and air-pump by means of a T-tube, *p*, *v*, one arm of which passed through the third hole in the lid of the apparatus. The tube, *a*, was closed by a stopper, through which passed the tube, *c*, of the Cailletet's apparatus, a tube connected with the drying apparatus, *u*, *u′*, and one limb of a T-tube, by means of which the manometer and air-pump could be put in connection with the interior of the vessel. The lower part of the whole apparatus was enclosed in a thick-walled vessel, *e*, containing a layer of phosphorus pentoxide.

By turning the valve, *k*, the vessel, *b*, could be partially filled



with liquid oxygen, which, under a pressure of 10 mm. of mercury, boiled at about −210° C. Almost immediately the gaseous air began to condense and collect in the tube, *a*; a supply of fresh air was constantly maintained through the drying tubes, *u* and *u′*, which were filled with sulphuric acid and soda-lime respectively. When the quantity of liquid air ceased to increase, the tap on the U-tube, *u*, was closed, the T-tube, *p′ v′*, was connected with the manometer and air-pump, and the liquid air was made to boil under a pressure of 10 mm. of mercury. In order to protect the liquid air from its warmer surroundings, a very thin, double wall tube, *f*, reaching to the level of the liquid in the outer vessel, was placed inside the tube *a*. When, as in some of my experiments, liquid oxygen was used in the inner vessel, this part of the apparatus was dispensed with.

Using the apparatus I have just described, I carried out two series of experiments, in which liquid air and liquid oxygen were employed as cooling agents. The tube of the Cailletet's apparatus was thoroughly exhausted by means of a mercury pump, and then carefully filled with dry helium. In the first series of experiments the helium, confined under a pressure of 125 atmospheres, was cooled to the temperature of oxygen boiling, first under atmospheric pressure (−182°·5), and then under a pressure of 10 mm. of mercury (−210°). The helium did not condense under these conditions, and even when, as in subsequent experiments, I expanded the gas till the pressure fell to twenty atmospheres, and in some cases to one atmosphere, I

could not detect the slightest indication that liquefaction had taken place. The first time that I compressed the gas I had, indeed, noticed that a small quantity of a white substance separated out and remained at the bottom of the tube when the pressure was released. Possibly this may have been due to the presence of a small trace of impurity in the helium, but it could not have constituted more than 1 per cent. of the total volume of the gas.

In the second series of experiments I employed liquid air, boiling under a pressure of 10 mm. of mercury. The helium was first confined under a pressure of 140 atmospheres, and then allowed to expand till the pressure fell to twenty atmospheres, or in some cases to one atmosphere. The results of these experiments were also negative, the gas remained perfectly clear during the expansion, and not the slightest trace of liquid could be detected. The boiling point of liquid air was taken, from my previous determination, to be -220° C. (*Comptes rendus*, 1885, p. 238). This number cannot, however, be taken as a constant, as the liquid air, boiling under reduced pressure, becomes gradually poorer in nitrogen. Further, the quantity of nitrogen lost by the liquid air on partial evaporation, varies not only with the rate of boiling, but even according to the manner in which it has been liquefied.

If air, under high pressure, be cooled first to the temperature of boiling ethylene, and then to -150° C., it liquefies, and, on reducing the pressure slowly, liquid air is obtained boiling under atmospheric pressure. During the process a considerable quantity of the liquid air evaporates, and the proportion of nitrogen to oxygen in the remaining liquid is less than in air liquefied under high pressure. If the liquid air, obtained by this process, be made to boil under a pressure of 10 mm. of mercury, the proportion of nitrogen in the mixture continues to decrease, but, on account of the large quantity of oxygen present, the liquid does not solidify, although its temperature is some 6° below the freezing point of nitrogen. When, as in some of my former experiments, the air was liquefied under normal pressure, by means of liquid oxygen boiling under a pressure of 10 mm. of mercury, the ratio of nitrogen to the oxygen in the liquid air was the same as in the gaseous air from which it had been produced. The liquid air, obtained by direct condensation at normal pressure, appeared to lose oxygen and nitrogen with about equal rapidity, and at the end of the experiment a considerable quantity of liquid nitrogen remained behind in the apparatus. On reducing the pressure to 10 mm. of mercury the nitrogen solidified. Prof. Dewar has stated (NATURE, February 6, 1896, p. 329) that liquid air solidifies as such, the solid product containing a slightly smaller percentage of nitrogen than is present in the atmosphere. My experiments have proved this statement to be incorrect; liquid oxygen does not solidify even when boiling under a pressure of 2 mm. of mercury.

After carrying these experiments to a successful conclusion. I found that it was yet necessary to prove that, on reducing the vapour pressure of boiling oxygen to a minimum, no corresponding fall of temperature takes place. The vessel, *c*, was partially filled with liquid oxygen, and, by means of a small syphon, a small quantity of the liquid was allowed to flow into the tube, *a*. The inner vessel, *a*, was then connected with the air-pump and manometer, and the pressure was reduced to 2 mm. of mercury. The oxygen remained liquid and quite clear. In a second experiment the temperature of the liquid oxygen, boiling under 2 mm. of mercury pressure, was measured by means of a thermometer. The temperature indicated lay above -220° C., a temperature easily arrived at by means of liquid air. I therefore concluded that liquid air was a much more efficient cooling agent than liquid oxygen, and that it would be quite unnecessary to make further experiments on the liquefaction of helium.

In every single instance I have obtained negative results, and, as far as my experiments go, helium remains a permanent gas, and apparently much more difficult to liquefy than even hydrogen. The small quantity of the gas at my disposal, and, indeed, the extreme rarity of the minerals from which it is obtained, compelled me to carry out my investigation on a very small scale. Using a larger apparatus, and working at a much higher pressure, I could have submitted the gas to greater expansion. Further, I should have been able to measure the temperature of the gas at the moment of expansion by means of a platinum thermometer, as I did when working with hydrogen; but to make such experiments I should have required 10, if not 100 litres of the gas. As I was unable to determine the temperatures to which I cooled the gas, by any experimental means, I have been obliged to calculate them from Laplace's and Poisson's formula for the change of temperature in a gas during adiabatic expansion.

$$T/T_1 = (p/p_1)^{k-1/k}$$

Where:—

T, p are the initial temperature and pressure of the gas.
T_1, p_1 are the final temperature and pressure of the gas.
k is the ratio (cp/cv) which, for a monatomic gas, is 1·66.

In the first series of experiments the gas, under a pressure of 128 atmospheres, was cooled down to -210° C.

p	T	p_1	T_1	
At.	°	At.	°	°
125	210 C.	50	−229·3 C.	43·7 A.
—	—	20	−242·7 C.	30·3 A.
—	—	10	−250·1 C.	22·9 A.
—	—	5	−255·6 C.	17·4 A.
—		1	−263·9 C.	9·1 A.

The results of these calculations tend to show that the boiling-point of helium lies below -264° C., at least 20° lower than the value I have found for the boiling-point of hydrogen. If the boiling-point of a gas be taken as a simple function of its density, helium, which, according to Prof. Ramsay's determination, has a density 2·133, more than double that of hydrogen, should liquefy at a much higher temperature. Both argon and helium have much lower boiling-points than might be expected, judging from their densities. This anomalous condition may be accounted for by the fact that in each case the molecular structure is monatomic, as shown by the values obtained for the ratios of their specific heats.

The permanent character of helium might be taken advantage of in its application to the gas thermometer. The helium thermometer could be used to advantage in the determination of the critical temperature and boiling-point of hydrogen. To determine whether the hydrogen thermometer is of any value at temperatures below -198° C., I carried out a series of experiments, in which I measured the temperature of liquid oxygen boiling under reduced pressure. I made use of the identical thermometer tube employed by T. Estreicher (*Phil. Mag.* [5] 40, 54, 1898) as a hydrogen thermometer for the same purpose, and applied the same corrections as were made in his experiments.

Pressure.	Temperature.	
	Helium thermometer.	Hydrogen thermometer.*
mm.	°	°
741	−182·6 C.	−182·6 C.
240	−191·8 C.	−191·85 C.
90·4	−198·7 C.	−198·75 C.
12	−209·3 C.	−209·2 C.
9	−210·57 C.	−210·6 C.

The results of these experiments prove that the coefficient of expansion of hydrogen does not change between these limits of temperature, and that the hydrogen thermometer is a perfectly trustworthy instrument even when employed to measure the very lowest temperatures.

I have already pointed out (*Wied. Ann.*, Bd. xxxi. 869, 1887) that the gas thermometer can be used to measure temperatures which lie even below the critical point of the gas with which the instrument is filled. For instance, the critical temperature of hydrogen, which I have found to be $-234·5^\circ$ C. (*Wied. Ann.*, 56, 133; *Phil. Mag.* [5] 40, 202, 1898) can be determined by means of a hydrogen thermometer. The helium thermometer could be used at much lower temperatures, and would probably give a more exact value for the boiling-point of hydrogen than it is possible to obtain by means of a platinum thermometer.

ON PERIODICITY OF GOOD AND BAD SEASONS.[1]

I FEEL some reluctance in coming forward to-night, with the result of my investigations into the periodicity of good and bad seasons—floods and droughts if you will—because they must come to you as a surprise, and they will make a claim on your confidence which at first sight you will probably not be disposed to grant. For myself I know that some years ago, if any one had come to me stating that it was possible to forecast the seasons many years in advance, I should have received the statement with incredulity. The difficulty in getting the facts together is very great. I have had to ask from history records of passing phenomena which it has been the habit of the historian to neglect; however, there will be before you a mass of evidence in support of my proposition, *that there is a periodicity in weather*. The weak point in the evidence is that history has not kept a regular and continuous account of droughts, but only recorded them when they became very prominent. The strong point is that all the data that history does give us is in favour of the nineteen years' cycle.

And it may be explained that the word drought is not used here in the sense in which it is often used in England and elsewhere, that is, to signify a period of a few days or weeks in which not a drop of rain falls; but it is used to signify a period of months or years during which little rain falls, and the country gets burnt up, grass and water disappear, crops become worthless, and sheep and cattle die.

Drought is, however, not wholly made by a deficiency of rainfall. Its most important factors are great heat and drying winds. As an illustration we may look to the year 1895; in the latter part of winter and in spring there were many falls of rain, which would have made grass in ordinary seasons, although there was not as much as usual, but it had no sooner fallen than a dry north-west wind and burning sun dried it all up. This great and burning heat was a well-known feature in historical droughts, and some authorities say that the fable of Phaëton driving the chariot of the Sun so close to the earth that he set it on fire, is a poetical setting of an actual experience in Greece when the sun became so powerful that the heat was almost beyond endurance.

Before 1895 all the diagrams I used had been made to show quantities of the various elements, and their relation in time, with a view to seeing if there was any periodicity. Recently it occurred to me that it would be useful to have a diagram in which all the droughts, without regard to their intensity, should be placed in their order of time; not only was this desirable for seeing what the relation in time was, but it had become evident that it would be impossible to see the relation between our droughts and those in other countries, unless some such pictorial arrangement was made.

As a preliminary to making the diagram, the particulars of the weather in this colony from all sources, for every year of our history, were carefully examined, and the years simply classed as good or bad; that is, having sufficient or insufficient rainfall. A form was then prepared with a vertical space for each year, and across these a zero line was drawn to divide the good from the bad; and, beginning with 1895, I filled in for that year, and below the line, a convenient length of the column in red ink; the length was simply to catch the eye. Then for 1894, a good year, I filled in with black ink, above the line, a space equal to the red in the vertical space for 1894. The two years were thus contrasted simply as good and bad; the question of how good, or how bad, was purposely left out. The diagram was then completed, each year being treated in the same way back to 1788. It was at once apparent that a drought lasting from three to seven years was most regular in its occurrence. A vertical red line was then drawn between the first and second years of each of these dry periods, and it was found that the interval between two successive lines was regular and exactly nineteen years. The centres of another set of dry periods, more intense and relatively shorter than the first series, were found also to recur at intervals of nineteen years. One of these droughts falls regularly between a pair of the more extensive droughts previously referred to.

In the whole period, from the foundation of the colony of New South Wales to the present year, *i.e.* 108 years, it is certainly very noteworthy that the most pronounced droughts recur with great regularity—that is, at every nineteen years throughout the 108 years. Indian droughts seem to have coincided with Australian ones in many instances.

The investigation had become interesting, and seemed to promise to show the exact year of the great drought in this country, of which there was abundant evidence when the colonists landed here, both in the fact that to the south of Sydney all the very large trees were dead, and between them were growing young trees; and the story of the blacks, who said that the river Hunter dried up; that all the great trees died, and most of the blacks; that those who survived had obtained drinking-water from the mountain springs. I had long wanted to find out when this terrible drought in this colony took place, and the Indian record showed that the extensive drought had been repeated in 1769-70, which probably fixes the date; for the middle of the eighteenth century was very dry, generally, all over the world.

But, if we can carry the nineteen years' period in this way back beyond our history, the idea immediately presents itself, where are you going to draw the limit, is there any limit? It was evidently not a question for argument, but for proof or disproof by figures. Tables were prepared showing every date on which droughts of the first class recurred back to A.D. 1, and the same for droughts of the second class. I am not going to weary you by going through the list, but will give you the result. History says very little about droughts prior to A.D. 900. Between that date and this, a drought has, on the assumption, occurred at every nineteen years. In this interval of nine hundred and ninety-six years there have been fifty-two repetitions of drought, and the question is what has history to say about its droughts. Well, it shows that these droughts have been repeated at various places on the earth on forty-four of the fifty-two dates; of these eight missing droughts, no less than six of them occurred between 1000 and 900 A.D., an interval when history was less complete on these matters. So far as I have gone, history furnishes us with seventy-eight droughts in different countries, all of which fit into the first series. During the same period, droughts of the second series recurred fifty-one times, and history records droughts, numbering eighty-nine, on thirty-six of these periods. Taking then the droughts history has recorded between A.D. 900 and 1896, we have seventy-eight of the first series and eighty-nine of the second, a total of one hundred and sixty-seven, out of two hundred and eight on record; but this is not all, for another class of drought, which is irregular in Australia, seems to be more definite and important in the northern hemisphere, and twenty-six more out of the two hundred and eight belong to this series, making up the number to one hundred and ninety-three out of the total of two hundred and eight.

In estimating the importance of these figures, it must be remembered that, before 1788, North and South America, Russia, China, Persia, Turkey, Austria and Australia, all subject to frequent drought, yet did not, however, furnish to the numbers quoted more than you could count on your fingers; and it may be fairly assumed that if we had these records, and especially if history had made a point of recording droughts, we should have had drought recorded on every recurrence of the nineteen years' cycle, of the two chief series; but I think the evidence that history furnishes one hundred and ninety-three recorded droughts, every one of which fits into the cycle, justifies us in assuming that the nineteen years' cycle has been running for at least one thousand years, and may be trusted to continue and justify forecasts based upon it for some time to come.

Having got so much from the study of droughts in the Christian era, it seemed desirable to see if there were any recorded in B.C. times. Records of twenty B.C. droughts were found, all of which, with one exception, fit into our nineteen years' cycle. If these dates are examined apart from their connection with Australian droughts, we find that the intervals between them are multiples of nineteen years, which shows that droughts then, as now, occurred in cycles of nineteen years, which is very strong evidence in favour of our theory, the more so when it is remembered that all the B.C. droughts I have been able to collect, except one, do fit in: they do not form a series of droughts selected for the purpose of supporting it; again, taking the dates given in the various works, the intervals between all these B.C. droughts and those in Australia are multiples of nineteen years.

If it be objected that chronologists have grave doubts about the accuracy of B.C. dates, I reply, that it is quite certain that chronologists did not arrange the dates to make them fit into an

[1] Abridged from a paper read before the Royal Society of New South Wales, June 3, by H. C. Russell, C.M.G., F.R.S.

unknown cycle running amongst these droughts, or in connection with Australian droughts, the dates of which have been unknown until now. These dates are points in history, and the fact that they fall into a cycle of weather, itself supported by all the available drought dates of the last thousand years of history, is in strong confirmation of the accuracy of these B.C. dates.

These intervals in which our droughts are found repeated are surprising, but I am not unaware of the differences of opinion in regard to chronology, but take the dates as given, and it is remarkable how exactly they fit in. But there is another point of importance hidden in these dates, and probably you have not noticed it. Pharaoh's drought was predicted, and a Jew was made chief man under the king, and he was doubtless versed in much of the wisdom of the priests, and carried that wisdom to the Jewish priests, who did not forget it, as the figures make manifest, and if warning of such evils could be depended upon, it is not likely they would forget it. The figures show that Elijah's prediction was a repetition of Pharaoh's drought 42×19 years after it; also Elisha's prediction was nineteen years after Elijah's, and it is noteworthy that the drought in David's time, although it does not appear to have been predicted, was 19×36 after Pharaoh's. This seems to me to be very strong evidence in favour of the view that the Egyptians knew of the nineteen years' cycle, and that the Jews brought the knowledge away with them.

Those learned in Assyrian antiquities tell us that the book containing "the Observations of Bel," the oldest astronomical book of that part of the world, was ordered to be kept by the king 3800 years B.C.; that book shows that they kept a record of astronomical and all other events, that they had discovered the nineteen years' cycle of eclipses, and we are told that it was a doctrine with them, that one event caused another, and all astronomical and meteorological observations were thus bound up together. Under such conditions I do not think it would be possible for them to avoid finding in the droughts a similar period to that in the eclipses, *i.e.* nineteen years; but even if they did, it would have been impossible for those who kept the Nilometer in Egypt to avoid finding it in the heights of the Nile floods, which were of such vital importance and so carefully recorded.

Since I have been working at this subject there have been a number of red rain storms noted in New South Wales, and the latest, on April 10, suggested to me this line of investigation. Red dust is obviously a proof of drought somewhere, otherwise the dust could not rise; and since these proofs of drought are entirely apart from the others, and recorded not as droughts but as marvels, which in days gone by created no little alarm, it will be worth while to see how far they support or contradict the nineteen years' cycle. The result of this resolution came as a surprise to me, because it was so unexpected; I had no idea there were so many records of red rains, or that they went so far back in history.

There are altogether sixty-nine recorded instances of the fall of red rain; of these I have recorded six for New South Wales. The first was fourteen years after the foundation of the city of Rome, that is in B.C. 738, and there are nine others B.C., all of which fit into the nineteen years' cycle; between 538 B.C. to 582 A.D. I can find no record of red rain, but from 582 to 1896 there are fifty-nine recorded falls of red rain, and all of them fit into the nineteen years' cycle. We have here, then, ten B.C. droughts which go with the eight mentioned before to make eighteen B.C. droughts in support of the cycle, the remainder, fifty-nine, are included in the previous list.

I have endeavoured to put before you some of the reasons which have convinced me that there is a cycle in weather; but the necessity for brevity in order to keep within the limits of one address, has rendered it necessary to express in a few sentences the results of many separate investigations, and the evidence does not seem so strong when thus condensed as it does when a number of facts one by one are brought to light from diverse sources, all of which individually support the proposition. I can assure you that the evidence was far more convincing when taken in detail; but want of time to get these details into one address, make this course impossible. Enough appears to have been said to prove that the cycle does exist, and to show the very great importance of this re-discovery of a law of climate which. there are many reasons to think, was well known to the Jews, the Egyptians, and other ancient peoples; they at least knew how to forecast droughts successfully, and in Egypt, like sensible people, made provisions for them.

An examination of the weather of one hundred years of New South Wales has shown that certain features recur every nineteen years; we have seen that the droughts of history—the great and conspicuous droughts I mean—all drop into this same cycle: both those that happened before the birth of Christ, and those that have occurred in our era; for instance, Elijah's drought happened in B.C. 908, that is, 2736 before our great drought in 1828, and the interval is 19×144. Great hurricanes, the great frosts of history, all the red rains, and all the droughts that history records, with a very few exceptions, likewise are included in this cycle, and the level of great lakes in Palestine, South America, and New South Wales are subject to the same mysterious influence that controls our weather.

As my investigation proceeded, the weight of evidence gradually converged upon the moon as the exciting cause. I have never had any sympathy with the theory of lunar influence upon weather, and received, rather against my will, the evidence that presented itself; still the logic of facts left no alternative but to accept the moon as prime motor. There has not been time to complete this investigation, and when finished it must form another paper. Meantime I may say that, so far, the comparison of the moon's positions in relation to the sun and earth and droughts shows that when the eclipses congregate about the equinoxes, that is, in March and September, they do so in the years which give us great droughts. Further, that when the eclipses accumulate in February and March, that is, at the vernal equinox and the month before it, and September, the autumnal equinox, and the month before it, August, we have the more intense and relatively shorter droughts of the second series, with heat, gales and hurricanes; on the other hand, when they accumulate about March and April, that is, the month of equinox, and the one following, and about September, the month of equinox, and October following it, we have droughts of the first series that are less severe, but much longer than the droughts of the second series. I have spoken chiefly of droughts; though, so far as our own history is concerned, it would have served the purpose just as well if I had taken up the periodicity of wet years, but outside Australia it would have been very difficult to get the necessary data, for history has much more to say about the horrors of drought than the abundance of wet seasons.

SNAKE VENOM AND ANTI-VENOMOUS SERUM.[1]

I HAVE already recorded in a series of memoirs published since 1892 in the *Annales de l'Institut Pasteur* and in the *Comptes rendus de l'Académie des Sciences*, the results of my researches on the venom of snakes, on the immunisation of animals against this venom, and upon the production of an anti-venomous serum. Prof. Fraser has confirmed the facts that I have published, and has successfully repeated almost all my experiments. I bring before you, to-day, a series of new facts relative to the same question. I may say at the outset, in contradiction of the opinion recently expressed by certain physiologists, that it is fully proved that the venoms of the various species of snakes produce physiological phenomena which have certain features common to all, and that the actions of these venoms only differ as regards their local effects. It is now possible to separate, artificially, the substances which produce the local phenomena from those which produce the bulbar intoxication. This separation may be effected by means of heat. If any sample of venom be thrown into watery solution and heated at 85° C. for a period of fifteen minutes, the albumin contained in the solution is coagulated and the phlogogenic substances are destroyed, whilst the toxicity of the substance is entirely unaffected. MM. Phisalix and Bertrand have already demonstrated this fact in the case of the venom of the viper found in France. After heating at 85° C. and filtration, all venoms, both viperine and colubrine, produce the same effects; they only differ as to the degree of their toxic activities. Similarly all are destroyed by the hypochlorites of the alkalis and by chloride of gold, the use of which substances I have suggested—particularly the hypochlorite of lime in a solution of

[1] Abridged from a paper read before the Section of Pathology and Bacteriology of the British Medical Association, by Prof. A. Calmette, Director of the Pasteur Institute, Lille.

1 in 60—for the local treatment of snake bites, to prevent the absorption of the venom.

Quite recently M. Phisalix, assistant in the Paris Museum, has announced that he has succeeded in separating the vaccinating substance of venom by filtering it through a Chamberland filter. The animals into which this experimenter inoculated the filtered venom did not die, and he found that they were vaccinated against the inoculation of a lethal dose of non-filtered venom. I have repeated these experiments with the greatest care, but the results that I have obtained are very different from those obtained by M. Phisalix. When a solution of normal venom is filtered through a Chamberland bougie a great part of the venom is kept back by the porcelain, just as is the case when microbic toxines are similarly filtered. It is certainly found necessary to use two and a half times more of the filtered venom than of the non-filtered venom in order to kill animals of the same weight; but if before filtration care is taken to separate the albumin of the venom by heat, it is found that the porcelain no longer keeps back any of the toxic substance. The animals are killed by the same dose of solution both before and after filtration. It follows very evidently, therefore, if the venom which has not been freed from albumin is less toxic after filtration than before, that this must be due to the fact that the albumin adheres to the porous wall of the filter, so forming a perfect dialysing membrane through which the venom can pass only with very great difficulty. I have been able to prove this by restoring a certain proportion of albumin by means of the addition of normal serum to venom that had previously been deprived of its albumin by heat. On filtering this venom containing the added albumin, I found that the liquid which passed through the filter was again considerably less toxic. Animals which have received filtered venom, and which have not succumbed after the lapse of three days, resist a minimal lethal dose of venom—*i.e.* they do not die; they are already vaccinated, just as are those that have been injected with a less than lethal dose of normal venom. There is, I believe, no reason to suppose that, as has been maintained by Phisalix and Bertrand, there is brought about by heat or by filtration of venom any separation of two substances, the one toxic and the other vaccinating, which are supposed to be found together in normal venom. This hypothesis does not appear to me to be justified by experiment, and it is absolutely certain that if one inoculates an animal with a quantity of heated venom, or of filtered venom of which the toxicity has been modified in sufficient quantity to kill the animal, it will react exactly as if it had been injected with a dose of normal venom a little below that required to produce death. In both cases, and in the same time, the animal acquires through this inoculation a state of resistance which enables it, at the end of several days, to receive with impunity an amount of venom capable of killing animals of the same weight. The serum of animals vaccinated against one species of very active venom, such as the venom of the cobra for example, is perfectly antitoxic as regards the venom of all other species of snakes, and also, as I have been able to prove, against the venom of scorpions.

The best method of procedure for the purpose of vaccinating large animals destined to produce anti-venomous serum consists in injecting them from the outset with gradually increasing quantities of the venom of the cobra mixed with diminishing quantities of a 1 in 60 solution of hypochlorite of lime. The condition and the variations in the weights of the animals are carefully followed in order that the injections may be made less frequently if the animals do not thrive well. Quantities of stronger and stronger venom are in turn injected, first considerably diluted and then more concentrated, and in order that the animals (horses) may give a serum equally active for the various phlogogenic substances which determine the various local actions it is necessary, when they have already acquired a sufficiently perfect immunity, to inject the venoms derived from as large a number of different species of snakes as possible. The duration of the treatment is of considerable length, at least fifteen months, before the serum is sufficiently active to be used for the purposes of treatment. The serum that we actually prepare at the Institut Pasteur, Lille, is active to the degree of 1 200,000th, that is to say, it suffices to inject, as a prophylactic dose, into a rabbit a quantity of serum equal to the 200,000th part of its weight in order to protect it against a dose of venom killing an animal of equal weight in three or four hours. If this serum be injected after the venom, it is sufficiently active in a dose of ½ c.c. given thirty-three minutes after the inoculation of a dose of venom lethal in three or four hours to prevent the death of the animal. Large quantities of this serum have been sent during the last few months to India, to Cochin China, to Australia, and to other countries where venomous serpents are most frequently met with, and we have already been able to collect certain interesting observations on people bitten. It is, however, very difficult in the greater number of instances to obtain information as to the species of venomous snake that has inflicted the wound. It has seldom been found possible to kill or capture on the field the snake inflicting the bite, so that all the statements as to the species of the snake which have not been so determined must be considered as open to some suspicion. I have already published one case, a most conclusive one, that of an Annamite bitten very severely in the hand by a cobra at the Bacteriological Laboratory of Saigon, who was cured by a single injection of 10 c.c. of serum. I have quite recently received the report of another very interesting case, for which I am indebted to Mr. Hankin, director of the laboratory of Agra in India. The patient in this instance was bitten by one of the most dangerous reptiles found in India, the Bungarus.

It has, indeed, been fully demonstrated, both by experiments on animals and by the actual treatment of snake bites in the human subject, that we have in anti-venomous serum a "specific" remedy which is very efficacious against venomous bites. It is, therefore, surely necessary to hasten to distribute it in all those countries where dangerous snakes are found. The only real difficulty consists in procuring sufficient quantities of venom for the immunisation of large animals, such as horses, to furnish adequate quantities of serum. The Pasteur Institute at Lille actually possesses enough venom, and horses completely immunised numerous enough for the most pressing wants. Serum prepared in an absolutely pure condition can be preserved for more than a year without losing any of its curative properties. In all countries where snakes claim their numerous victims, and especially in India, where the annual number of deaths resulting from venomous bites rises to about 22,000, it would surely be expedient that the various Governments should take steps to establish depôts, at least, in the principal agricultural, forest, and mining districts, where medical aid may be afforded as early as possible to every person bitten who comes to seek treatment. Each of these posts should be supplied with (1) a stock of serum, renewed each year; (2) hypodermic injection syringes; (3) a perfectly freshly prepared solution of hypochlorite of lime, and other medicaments and instruments necessary for the dressing of wounds. The expense of effecting such an organisation would be very slight. I ask you, gentlemen, to pass unanimously a resolution that may have the effect of inducing, or affording justification to, the Indian Government to realise this humanitarian scheme.

Dr. Calmette delivered a lecture, with experimental illustrations, in the Laboratories of the Conjoint Board of the Royal College of Physicians and Surgeons, on "The Treatment of Animals poisoned with Snake Venom by the injection of Anti-Venomous Serum." In the course of his lecture he said:

I have to-day the opportunity of giving you the results of experiments that have been performed under Dr. Woodhead's licence, but under my direct personal supervision, so that they may be depended upon as affording direct proof of the value of my method. Those animals that have been successfully treated you may examine for yourselves; others that have been poisoned with the snake venom, but have not received the serum, have succumbed; these latter serve as control experiments with which to compare the results obtained when the serum has been given.

These experiments are easily carried out, and are absolutely painless. In rabbits, as in the human subject, the first symptom indicating the action of snake poison is slight somnolence, which, becoming more and more marked, is gradually succeeded by a condition of unconsciousness associated with, first, muscular contraction and then with loss of motor power, which, commencing in the hind limbs, passes forwards until the respiratory centres are affected, the cardiac centre being the last attacked. When the animal dies, the heart is found in a condition of diastole. The venom may be injected in two ways—intravenously, when a comparatively small dose acts with great rapidity; and subcutaneously, when the dose also acts powerfully but more slowly. A lethal dose of cobra poison injected

subcutaneously is about 1 milligramme of dried substance, which proves lethal in about twelve hours. Twice this quantity injected into the veins kills a rabbit of about 1500 grammes in sixteen minutes. Five times as much introduced subcutaneously proves fatal in about three and a half hours. I may, however, give you the results of experiments devised to bring out the exact action of the anti-venomous serum, which experiments have been followed by those who are working in these laboratories.

To exhibit the efficiency of protective injections, at nine o'clock this morning four rabbits, weighing between 1450 and 1770 grammes, were injected intravenously in the lateral aural vein, each with 3 c.c. of the anti-venomous serum. This afternoon these rabbits have been injected intravenously with 2 milligrammes of dissolved dried venom sufficient to kill the animal in sixteen or seventeen minutes. None of these animals show any symptom of sleepiness, and it is evident that the venom will have little, if any, effect upon them. At the time that these animals were injected with the two lethal doses, two control rabbits, weighing 1340 and 1275 grammes respectively, were similarly injected intravenously with 2 milligrammes of the venom; these both succumbed to the symptoms above-mentioned, one in about sixteen minutes and the other in seventeen minutes. We have here, then, ample evidence of the great protective power that the serum exerts when injected into the body before the venom is introduced. In a second series of experiments, carried out to demonstrate the curative properties of this serum, six rabbits were similarly treated with 5 milligrammes of venom injected under the skin. Half an hour afterwards two of these animals received 3 c.c. of the serum intravenously; neither of them showed any symptoms of poisoning, and remained perfectly well. Two others of these poisoned animals, one hour after the venom had been introduced, were similarly injected intravenously with 3 c.c. of the serum; they also remained well. Two of the other rabbits should have been left for one and a half hours, but the dose of poison was so large that one of the animals succumbed at the end of an hour and twenty minutes; the other animal was immediately injected with the same dose of serum as above, with the result that it is now well, although the dose of venom was so large and had been allowed to act for so long a time—long enough, indeed, to kill the other animal injected at the same time. This is a very striking proof of the efficacy of the serum.

Although the anti-venomous serum does not act directly upon the toxin, but only through the cells, it begins to exert its influence immediately it is introduced into the body. This fact is well brought out by the following experiments:—Three c.c. of the serum were injected into the lateral vein of the left ear of a rabbit weighing 1280 grammes; fifteen minutes later this animal received into the lateral vein of the right ear 2 milligrammes of the venom, sufficient to kill it in less than twenty minutes had it not received the serum. The animal has remained perfectly well, and still shows no evidence of poisoning by snake venom. A more striking experiment still is one of which I give a description. A rabbit having received intravenously 2 milligrammes of venom, two minutes later is injected with 5 c.c. of the anti-venomous serum in the vein of the opposite ear. The animal has remained perfectly well.[1] Such an experiment shows that the venom does not destroy the cellular elements at once, and that even when the poison has already found its way to the circulation these cells may be rendered insensible to the action of the poison by means of the action of the serum.

[Dr. Calmette then gave extracts from the paper which he brought before the British Medical Association at Carlisle, and concluded by asking Dr. Woodhead to read the following.]

Gentlemen, the experiments that have been described to you concerning the efficacy of the "anti-venomous serum," the results of which you have before you, prove that the said serum really constitutes a specific remedy against venomous snake-bites. The use of this serum must necessarily become generalised at no distant date in all countries where venomous snakes are found, in order that both men and domestic animals may be protected. Is it not advisable, therefore, for the British or Colonial Governments, which are deeply interested in this matter, to take rigorous measures to prevent the sale in England and in its colonies of serums for which no absolute guarantee of efficacy and purity is given? I have the honour to propose that you will adopt the following propositions, and bring them in some way before the Government at as early a date as possible:—

(1) That there be instituted in London and in each British colony where there are found venomous snakes a sanitary committee, to be entrusted with the duty of testing the efficacy of anti-venomous serums offered for sale or sent out to be delivered gratuitously by druggists and others.

(2) That no bottle shall be sold or distributed unless bearing the mark of such control.

(3) That this control be effected according to the sole, simple, and rapid method which alone presents every guarantee of accuracy.

(4) The method proposed is the following:—A standard solution of venom will be placed at the disposal of the appointed experts. The toxic unit of this solution will be based on the quantity of venom necessary to kill a rabbit of 2 kilogrammes in twenty minutes by intravenous inoculation in the marginal vein of the ear, the above quantity corresponding on an average to 2 milligrammes of cobra venom (weighed dry) and to 4 milligrammes of rattlesnake venom. An anti-venomous serum, to be sufficiently active for therapeutic use, must be a preservative in a minimum dose of 2 c.c. on intravenous injection into a rabbit of 2 kilogrammes against an intravenous injection of the toxic unit of venom. The preventive inoculation must be made fifteen minutes only before the inoculation of the venom. The testing of the serum is thus effected in less than one half-hour.

(5) That stations provided with serum and all the necessary apparatus for its application be established in the principal centres of agriculture and in the mining and forest districts of the colonies infested with venomous snakes, such as Australia, Burmah, and India, so that every person bitten may be able to come at once and receive treatment.

[1] All these animals were still alive and in excellent health eight days later.

REPORT OF THE DEPARTMENT OF SCIENCE AND ART.

THE forty-third Report of the Department of Science and Art, dealing with the work of the Department during the past year, has just been issued in the form of a Blue-book. The report may be taken as a statement of the condition of elementary science teaching in this country; therefore, some of the facts and opinions contained in it are worth recording.

In the science division it is pointed out that in the decennial period, from 1886 to 1895, the number of schools has increased from 1682 to 2673, of classes from 5862 to 9545, and of students from 94,838 to 193,404. Of the 193,404 pupils under instruction in 1895, 188,380 come within the category of those on account of whose instruction payments on the results of examinations are made by the Department. Of the schools examined, 2139 were in England and Wales, 366 in Scotland, and 168 in Ireland. There were 113,398 individual students examined, and 52,079 were successful in passing in one or more subjects. The payments to Science Schools, exclusive of those made to Training Colleges on the results of the examinations for the year 1895, amounted to £142,543, an increase of more than £2000 on the preceding year.

Of the 2673 Departmental Science Schools in 1895, 115 were Organised Science Schools, that is to say, schools in which organised courses of instruction are followed. A new scheme of work for such schools came into force last year, and so far it appears to have worked satisfactorily. Practical physics was made obligatory in these schools by the new scheme, and the result is that while only a few years ago a physical laboratory was a rarity, one will shortly be found in every school in which science forms a proper place in the curriculum.

Mr. C. A. Buckmaster, one of the senior inspectors, places his finger upon a weak point in the education of teachers when he says, "the great failing of the elementary teacher as a science instructor is not want of knowledge, but want of ability to experiment." The reason is that few Training Colleges provide facilities for courses of experimental work, though such scientific practice should be an essential condition for the teaching of science subjects in the Elementary School Code.

Throughout the reports of the inspectors the welcome information is made known that experimental work in science is becoming more common, but there is still much room for improvement. The supply of apparatus is being largely increased, and laboratory accommodation is being extended. The chief difficulty to be contended with at the present time is the insufficient education of the students who join the evening classes. Especially is there a lack of knowledge of scientific principles, and there is a difficulty in getting students to take up subjects which lie at the bottom of all technical subjects. On this point Dr. H. H. Hoffert says: "It is much to be desired that as Technical Institutes multiply, and permanent staffs of well-qualified teachers become appointed, more encouragement may be given to students of evening classes to take up definite courses of study. Such students too frequently attempt the study of the more purely technical and applied subjects, without having the necessary knowledge of the underlying sciences, and in consequence of this the teaching is largely based on rule-of-thumb methods of practice, and is lacking in scientific generality and educational value. There is an undue disproportion in number between classes on such subjects as applied mechanics, steam, and mining, and those in theoretical mechanics, elementary physics, chemistry and geology."

In addition to the reports on instruction in science and art, the Blue-book just issued contains as appendices reports on the Royal College of Science, the South Kensington Museum, and other museums in connection with the Department of Science and Art, supported by the State. There is also in it the Report of the Director-General of the Geological Survey of the United Kingdom and the Museum of Practical Geology, and a Report to the Solar Physics Committee on the work done in the Solar Physics Observatory at South Kensington.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE appointments, recently advertised, at the Northampton Institute, Clerkenwell, have been filled as follows:—Mr. John Ashford, Lecturer on Engineering at the Birmingham Technical Schools, to be Head of the Mechanical Engineering and Metal Trades Department; Mr. John Williams to be Head of the Artistic Crafts Department; Mr. C. V. Drysdale to be Chief Assistant in the Applied Physics Department; and Miss Mary A. H. Gibbs to be Head Teacher in the Domestic Economy School.

THE Technical Education Board of the London County Council has addressed a letter to the Councils of University and King's Colleges on the subject of the financial assistance to these institutions during the forthcoming session. It is pointed out in this letter that the Board cannot undertake to ensure regular annual grants towards either of these colleges. It is further recommended that the Councils of the two colleges should confer together before making any application for assistance, with a view to coordinating the work now specially carried on in connection with Oriental languages. A question has been raised with regard to King's College, as to whether the Board can legally make a grant to an institution of a denominational character. But since the discussion of these questions will take some time, it is proposed to continue the grants of £1500 to University College and £1000 to King's College for next year, on the understanding that such a conference shall be held.

THE following complaint, which has been made by *The Local Government Journal*, is not, we think, borne out by the reports of the technical education committees of those County Councils which administer the affairs of the agricultural counties, and which have been sent to us from time to time. The paragraph runs thus: "If technical education committees would bestir themselves and give lessons in thatching, hedging, ditching, sheep-shearing, and so on to the men, instead of providing an afternoon's amusement for labourers' wives in showing them how to make butter without having a cow to produce the milk, and similar instruction for farmers' wives and daughters when the ladies of the farm have no intention of making butter, or of bending their backs to skim the milk, much more good would be done than is accomplished at present, and a great waste of treasure would be obviated." More than one committee in charge of technical instruction would be grateful to our contemporary for some successful method of getting farm-labourers together for the purpose of agricultural instruction, though we have our opinion of the wisdom of teaching the subjects named, even if these arts are not included in the well-known restriction of the Technical Instruction Act.

SCIENTIFIC SERIALS.

American Journal of Science, August.—Molluscan archetype considered as a *veliger*-like form, by A. E. Verrill. In the form of molluscan larva known as *veliger*, and in its slightly younger stages, we have organisms that swim free, often seek their own food, and seem to have claims to be considered the nearest living representatives of the ancestral molluscan archetype, or archetypes, for it is quite probable that the different classes of Mollusca have descended from distinctly differentiated *veliger*-like organisms. In general, it may be stated that nearly all Gastropoda, except certain terrestrial and fresh-water forms, pass through *veliger* stages. The same may be said of Bivalvia, Scaphopoda, and Pteropoda. Cephalopoda, on the other hand, seem to have an abbreviated development, like terrestrial Gastropoda, and leave the egg with the general structure of the adult. It is probable that each of these great classes were originally small, free-swimming forms, furnished with a ciliated locomotive organ similar to the velum of modern veligers. The primitive Cephalopoda had probably a similar origin from a *proveliger* like that of some pteropods and gastropods. On the other hand, it seems impossible to derive a cephalopod or a bivalve from a creeping chiton-like archetype such as Lankester has proposed.—An apparatus for the rapid determination of the surface tensions of liquids, by C. E. Linebarger. The apparatus is based upon Jäger's method of employing two capillary tubes of different bore immersed in the liquid, and measuring the difference of the depths to which they were plunged when air bubbles forced out of them at the bottom required the same air pressure. The tubes employed had bores ranging from 0·1 to 1·5 mm. Two tubes were mounted in clamps in a stand over a test tube containing the liquid, and immersed in a water or glycerine bath. Air pressure was applied, and the orifices were shifted until the liquid was pushed down to the orifices, and there the heights were carefully adjusted until equal streams of bubbles issued from both orifices. The surface tensions were found by the formula

$$\gamma = chs + s^2$$

when γ is the surface tension in dynes per cm., c the apparatus constant, h the distance between the ends of the tubes, and s the specific gravity.—Wardite, a new hydrous basic phosphate of alumina, by J. M. Davison. Mr. Packard's "variscite" from Utah occasionally leaves on decomposition some cavities in the nodules, and encrusting these cavities is a hydrous basic phosphate of alumina, which appears to be a new mineral. It is a light green or bluish green, with vitreous lustre, concretionary structure, hardness about 5, and density 2·77. Its formula is $Al_2(OH)_3PO_4$, and it forms a series with Peganite and Turquois.—On the existence of selenium monoxide, by A. W. Peirce. The author has been unable to find evidence of the existence of the monoxide, either gaseous or solid, and his experiments go to show that the peculiar smell of decayed cabbage, attributed by Berzelius to the monoxide, is only developed when selenium is heated in presence of moisture, if only a mere trace, and is probably due to selenium hydride.

Bulletin of the American Mathematical Society, vol. ii. No. 9, June.—The motions of the atmosphere, and especially its waves, is a translation, by Prof. Cleveland Abbe, of an address by Dr. E. Hermann, which was delivered before the Meteorological Section of the Association of German Naturalists at the annual meeting held in Vienna, September 25, 1894. The author states that the inadvisability of the views according to which the motions of the atmosphere consist in the development of independent cyclones and anticyclones is, of late years, more and more plainly recognised. This conclusion has been arrived at, not so much through a severe criticism of the fundamental basis upon which these erroneous views had been established, as by the power of the facts that resisted introduction into this artificial system. He traces this change of view

to the influence of a memoir by Hann, published some ten years since, and then points out that the idea was further developed in von Helmholtz's "Mechanics of the Earth's Atmosphere." He then expounds his own method, and closes with the hope that it may lead meteorology out of the region of vacillating ideas that now control it into a broader field, and "place it among the exact sciences, where everything is reduced to numerical computation, and thus, to an important extent, further its application to daily practice."—Prof. Osgood writes on some points in the elements of the theory of functions.—On the motion of a homogeneous sphere or spherical shell on an inclined plane, taking into account the rotation of the earth, by Prof. A. S. Chessin, discusses some interesting illustrations akin to Foucault's experiments with the pendulum and the gyroscope.—From the Notes we learn that the Council have arranged for a colloquium in connection with their summer meeting at Buffalo, at which are to be delivered two courses of six lectures each, viz. on the subject of linear differential equations and their application, by Prof. M. Bôcher, and on the Galois theory of equations, by Prof. J. Pierpont.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 10.—M. A. Cornu in the chair.—Researches on cyanic acid, by M. Berthelot. By studying the reaction between acetic acid and potassium cyanate it was found to be possible to separate the heat evolved by the simple replacement of the cyanic by acetic acid, from the heat evolved in the subsequent decomposition into ammonia and carbon dioxide. The value thus found for the heat of neutralisation of cyanic acid (12·25 calories) was confirmed by the observation that no reaction takes place between potassium cyanate and boric acid (heat of neutralisation, 11·6 calories).—Researches on the volatility of lævulic acid, by MM. Berthelot and André. Lævulic acid is slightly volatile *in vacuo* at ordinary temperatures. Analysis of the residual acid showed that its composition was not quite the same as the original acid, possibly owing to the formation of an anhydride.—On the reactions taking place in the cold between phosphoric acid and ether in the presence of water, by MM. Berthelot and André.—M. Marcellin Langlois presented two memoirs on thermochemistry.—On the lunar photographs offered to the Academy by M. Weinek, Director of the Prague Observatory, by M. Lœwy.—On the part played by the dielectric in the discharge by the Röntgen rays, by M. Jean Perrin.—Photography in the interior of a Crookes' tube, by M. G. de Metz. By the use of the method previously described, it has been found possible to draw up tables of relative permeabilities to X-rays and kathode rays. With the exception of lead, which is slightly more transparent for the kathode rays than for the X-rays, the two tables are identical, and even this exception appears to be capable of explanation. The kathode rays, like the X-rays, appear to be non-polarisable.—Remarks on the preceding communication, by M. H. Poincaré. In the experiments described in the previous paper, the kathode rays have to traverse a piece of card. It has still to be shown that this card does not give out X-rays.—Researches on the principles of vegetable digestion, by M. V. Poulet. The carefully-cleaned root-hairs of a number of plants gave, on pulverising and extracting with dilute acid, traces of ferrous tartrate. This appears to play an important part in the process of vegetable digestion; and it is suggested that, in the absence of iron in the soil, it is the non-formation of this salt which causes etiolation: that chlorophyll itself in the pure state contains no iron, being now well established.—On a new property of the corpuscle of the silk-worm disease, by M. J. M. Krassilschtchik.—On the heterogamic fertilisation of the algæ *Ectocarpus secundus*, by M. C. Sauvageau.—Alteration in the elimination of phosphates, under the influence of the Röntgen rays, by M. L. Lecercle. The rate of elimination of phosphorus appears to be increased.

NEW SOUTH WALES.

Linnean Society, June 24.—Mr. Henry Deane, President, in the chair.—A new family of Australian fishes, by J. D. Ogilby. In this paper the author proposed to segregate in a new family, under the name *Melanotæniidæ*, certain small fresh-water percesocoid fishes belonging to the Austrogæan region, which differ from all other members of that group by the structure of the first dorsal fin, which consists of a single stout and pungent ray followed by two or more flexible unarticulated rays; by the thoracic insertion of the ventral fins, &c.—New genera and species of Australian fishes, by J. D. Ogilby.—On the Australian *Clivinides* (Fam. *Carabidæ*), by T. G. Sloane. Thirty-one new species of *Clivina* were described, bringing the total for Australia up to eighty-three, divisible into thirteen groups.—On the bag-shelters of certain lepidopterous larvæ of the genus *Teara*, by W. W. Froggatt. A general account is given of the curious bag-like diurnal shelters fabricated by the gregarious larvæ of moths of the genus *Teara*, with particulars of the life-history of *T. contraria* bred from nests obtained near Sydney.—Diatomaceous-earth deposits of the Warrumbungle Mountains, by Prof. T. W. E. David.—In the neighbourhood of the diatomaceous-earth deposits two formations are represented: (1) the permo-carboniferous coal measures and (2) trachyte lavas, dykes and tuffs, with which last are associated the deposits of diatomaceous-earth, and a seam of lignite. At one of the outcrops, fossil leaves (*Cinnamomum Leichhardtii*, Ettingsh.) occur on a horizon immediately above and intimately associated with the diatomaceous-earth. The latter is largely made up of diatoms (the genus *Melosira* predominating) and sponge spicules; and the age of the deposit is provisionally set down as early Eocene or late Cretaceous. The author emphasised and discussed the significance of the fact that all the diatomaceous deposits hitherto found in New South Wales occur in association with volcanic rocks.

CONTENTS.

THURSDAY, AUGUST 27, 1896.

PROFESSOR OSTWALD ON ENGLISH AND GERMAN SCIENCE.

PROF. RAMSAY has done good service by communicating to the *Times* a letter he has received from Prof. Ostwald of the highest importance at the present time, when, fortunately for us, German supremacy along many lines of applied science and the causes of it, are being at last recognised.

No one has a better right to speak on this subject than Prof. Ostwald, and the fact that we may take his communication as one made in the interests of British science makes it all the more valuable.

What he says will be no news to the readers of NATURE, because for years past we have been pointing out the rocks ahead and the steps necessary to avoid them; but our voice has been as that of one crying in the wilderness. Fortunately for us this is so no longer. The *Times* devotes a leader to Dr. Ostwald's letter, which we give in another column, but it does not appear that even the *Times* is in real touch with the actual position.

"The Germans have found that nothing pays so well as knowledge, and that new knowledge always pays in the long run. They act on this principle by maintaining a steady demand for men competent to extend the domain of theoretical knowledge, paying them well for doing it, and taking their chance of one valuable practical discovery turning up among a score that for the present lead to nothing. How good that chance is may be judged from the enormous success attending German chemical industries of all kinds. Germany controls the fine chemical markets of the world, and that means that she takes tax and toll of almost every industry in every country. How easily we might have forestalled her can be fully understood only by those who know what a splendid start we had in capital, in machinery, in control of markets, and in root ideas. Some of her most lucrative industries have been developed out of English discoveries, due to the genius of individual Englishmen, but never properly grasped and worked out by English manufacturers. Her commercial domain will go on extending, and ours proportionately shrinking, unless Englishmen become practical enough to look beyond their noses, and wise enough to believe in knowledge."

This is excellent; but then we are also told—

"For any healthy reform we want driving power, and the driving power must come from manufacturers enlightened enough to understand the secret of German success and English failure. It is industry that must endow research, not from any unpractical desire to add to the number of useless persons who know all that has been done, yet do not know how to do anything new, but from the very practical desire of manufacturers to extend their business and add to their profits."

And again:—

"There is a clamour now and again for State aid, and Dr. Ostwald's letter will, perhaps, stimulate it, because he refers to the action of the State in Germany. But the root of the matter in Germany lies in private enterprise, and it must do so here. Heaven helps those who help themselves, and the State cannot do better than observe the same limitation. When industry endows research it will be time to ask for assistance from the taxpayer. Until then State endowment of research can mean little more than throwing money away upon abstract acquirements having no real relation to the facts of national prosperity."

Let us accept for a moment that "industry," "manufacturers," and "private enterprise" in Britain at once proceed to do all that the *Times* lays at their doors. What then? Prof. Ostwald answers this question by telling us what the Prussian Government and the various German States have done and are doing for research and scientific education, above and beyond all the efforts made by German "industry," "manufacturers," and "private enterprise."

In such a competition Britain, without the State aid so amply and wisely given in Germany, is certain to lose.

It has already been pointed out in these columns, and it is worth while to re-state it, that the connection between our national greatness, our national defences, and our commerce, is universally recognised, and that the State spends, and properly spends, tens of millions a year, the protection of our commerce being assigned as one of the ostensible reasons.

But another thing which as yet is not generally recognised is that so surely as our national greatness is based upon our industries, as surely in the future must our industries be based upon science.

It is clear, therefore, that if in other countries the advancement of science is the duty not only of individuals, but of States, mere individual effort in any one country must be crushed out in the international competition which is growing keener and keener every day.

Taking things as we find them, we spend tens of millions a year to protect our commerce which is a measure of our industries; while the basis of these, science, is to remain unprotected, unorganised, and unaided, except by local efforts and the action of individuals.

Surely such a contention cannot be seriously maintained—such inconsistent action can have no logical basis. The real remedy lies in consistently organising both our peace and our war forces, as Huxley pointed out many years ago. We have now a War or Industries-protecting Council: by the side of it we want a Peace or Industries-producing Council; in other words, a strong Minister of Science, who shall have as complete a staff of men of science to advise him as the President of the War Council finds himself provided with in the heads of the Army and Navy Departments.

Only in this way can Germany's flank be turned. If it were only a question of ironclads how readily everybody would agree.

Another part of Prof. Ostwald's letter, for which thanks are due, is that in which he points out that in Germany research is as important an engine in Education as it is in a Chemical Works; so that again the call upon "private enterprise" is not sufficient.

Here, of course, the whole question of our University organisation is raised. We cannot pursue it now, but we may quote a pregnant passage from Prof. Fitzgerald's letter, also printed elsewhere—

"The most serious cause of complaint of modern society against the old universities is that they have so controlled

the education of the wealthy classes of the community, that the landed and professional classes have been educated apart from the commercial and industrial classes, to the very great injury of both."

This is the reason that the true condition of things has not been appreciated long ago. It is not understood, and therefore it is not believed. Our political leaders, the permanent chiefs of the various public departments, have not the slightest idea what all this fuss is about, because their education has been entirely apart from those regions of thought and work in which in the future the peaceful battles of the world will be fought and won; if not by us, then by others, for fighting there must be.

No better argument could be found for the establishment of a ministry and council of science than was afforded by two speeches delivered some little time ago by the Duke of Devonshire on matters connected with scientific education, and of which condensed reports were given in NATURE at the time. The Duke candidly confessed at Birmingham that he was not placed at the head of the educational and scientific affairs of the country on account of any special knowledge of the subjects, for "his knowledge of science and art could be compressed into two nutshells." It is not our desire to utter one word against the Duke of Devonshire for his candour; he has shown that he is interested in technical education, and has on more than one occasion assisted the work of science. But what we do criticise is the political system which does not consider it necessary that the educational and scientific welfare of the country should be the business of those who are able to appreciate the work done, to see the necessity of reforms, and to know the directions in which developments should take place. In almost every other country the State or Government has official men of science among its servants, and also constantly ask the advice and assistance of their academies and learned societies, when questions of technical and scientific interest are being discussed; but here no such use is made, either of the societies as a whole or of the men who constitute them.

CARL VOGT.

La Vie d'un Homme: Carl Vogt. By William Vogt. 4to vol. of 264 pages, with two portraits by Otto Vautier. (Schleicher Brothers, *ex*-Reinwald. Paris, 1896.)

A PHILOSOPHER he was—there is no doubt about that; but none of the quiet sort who "leave controversy to the little world below them": he was one of the fighting portion, and while none have known him to step out of his path to avoid a skirmish, he has often gone far from his track for the mere pleasure of picking up some battle. To him life was movement, and a true account of his years should include more than the history of his scientific work. The latter has been reviewed in NATURE for May 30, 1895, and a very full account thereof has been also given by his pupil and friend, Emile Yung, in *Revue Scientifique*, dated June 22, 1895. M. William Vogt, his son, now proceeds to tell us the essentials of his life; and although the large book before us deals but slightly with the scientific features of the lamented naturalist, still scientific readers will find much in it to interest them, in the way of anecdotes concerning Vogt's relations with men of his time, and letters of the latter.

Carl Vogt was born on July 5, 1817, at Giessen, in Germany, the eldest of nine children. Celtic blood was predominant in his veins, not Germanic, and much in his character and wit was distinctively Celtic. The son of a distinguished physician and professor, Carl had an uneventful youth. To put it short, he was lazy, and Gall could certainly not locate the "bump of respect" or of submissiveness on that head. His father was assured that the masters allowed him to pass from class to class, each year, only to get rid of this turbulent and undisciplined pupil; and it is well known that the aforesaid "bump" never grew. After the school-days, Carl was sent to the medical faculty, where he did more fighting and duelling than reading or study, and entered Liebig's laboratory. He was engaged in an investigation of the amniotic liquid (published in Müller's *Archiv*, 1837), when an event occurred which stands at the basis of all Vogt's political troubles. A law student, implicated in the Marburg plot, and a republican, begged of Vogt to help and conceal him, as the police were in search of him. Vogt—a nephew of the three republican brothers Follenius—complied immediately, and hid his fellow-student in his own room, although the next day it was officially announced that five years' imprisonment in a fortress was the penalty for such offence. A week elapsed, quietly, when one day, Liebig took Vogt aside. Liebig knew the facts, and had heard that the police also were informed; it was high time for Vogt to run. At once Vogt went home, and the same evening the refugee and himself left, in opposite directions, early enough to avoid being captured. Carl Vogt fled to an uncle of his, near Darmstadt, and spent a few weeks there, disguised by his uncle—an inspector of forests—as a forest official, and in this character taking part in the chases of the very *Gross-Herzog* himself, whose police were after Vogt. Some weeks later, he managed to cross the Rhine, and, with the help of friends, to put his feet on the French soil; he was then out of trouble. His father desired him to pursue his medical studies, and in 1839 he graduated in Bern *maxima cum laude*. But little he cared about medical art. Valentin, the physiologist and anatomist, had been interested in the young student, and wished to bring him over to zoology and physiology. Vogt took very kindly to the hints, and to Valentin's lessons, and undertook most willingly to investigate the nervous system of some South American reptiles collected by Humboldt. Hence two papers ("Neurologie von Python tigris" and "Neurologie der Reptilien," 1839-40) which are the first anatomical work of Carl Vogt, the last being more than fifty years younger. At this period, circumstances—too long to relate—put Vogt, and Edouard Desor his friend, in contact with Louis Agassiz, and they decided of Vogt's scientific future: he was bound to become a naturalist. Vogt set to work in most determined manner at Agassiz's "Poissons d'Eau douce" and at the "Embryologie des Salmonés," publishing in the meantime his

interesting paper on "Alytes obstetricans." An amusing anecdote finds its place here. One day Desor, while dictating to a young *famulus* a sentence, said, in order to surprise him: "This specimen is distinguished from others (other fishes) by this characteristic, that it has the head where the others have the tail." The *famulus* never winced. The copy went to the printing-house, and the proofs came in due time. But the wonder is that, while Desor, Vogt, and Agassiz—*deus ipse*—went over the proofs and corrected them, none noticed the absurd sentence, and it is only after fifty copies had been printed off that Desor remembered his "little joke," and stopped the proceedings. Let writers be lenient towards printers and proof-readers; such is the moral of this story.

At the same time, Agassiz, aroused to the interest of glacial studies by Venetz and Jean de Charpentier, began his historical fight against Elie de Beaumont and von Buch, and, in order to settle the matter, decided to investigate glaciers thoroughly. Thus originated the Hotel des Neuchatelois expedition, when Agassiz, Desor, and Vogt settled on the Aar glacier, and made a sort of cabin under a huge boulder which had fallen from the Schreckhorn, and upon which the names of the party were scratched, still legible, in part, a few years ago. Two summers were spent there in great activity; the "Agassiz factory," as not over-respectful Vogt used to call the association, being under its highest pressure. The Neuchatel period had its outcome—as far as Vogt alone is concerned—in the publication of "Im Gebirg und auf den Gletschern," studies on the fauna of red snow, and a severe discussion with von Buch. The latter was not convinced, but bore no grudge towards the young "Mutz" ("Mutz" is Bernese *patois* for bear, a surname given to Vogt by his friends) for his attacks, and even allowed that "aus dem kerl wird noch etwas werden."

Vogt and Agassiz were not to agree very long. To ascertain the exact cause of their estrangement would prove perhaps difficult. Ernst Haeckel has been very clear and positive on one point, however, and he denounces Agassiz as having been "the most active and clever *chevalier d'industrie* who ever worked in the field of natural history," "clever" being taken in its none too favourable sense.

Agassiz seems to have practised *Ich nehm es mit* on a large scale, taking an unfair advantage of his younger co-operators, and not giving them the credit which was due to them for their share of the work. Carl Vogt and Desor accordingly retired, and the scientific partnership of the Hôtel des Neuchatelois was dissolved. This was in 1844. Paris could hardly fail to attract Vogt, and thither he directed his steps. His friends, or masters, were Ehrenberg, the revolutionist Bakounine, von Baer, Quételet, Arago, Milne-Edwards, Leverrier, de Jussieu, and many others of equal fame. Three years were spent then, at hard work. Vogt published his investigations on the development of gasteropods, and his "Lehrbuch der Geologie und Petrefactenkunde." The latter, but little known in England or in France, was much appreciated in Germany, and much read; many editions were brought out, always kept *au courant*. The last is dated 1879. In Paris also he wrote his celebrated "Physiologische Briefe," of which Russian, German French, and Italian versions are extant. The book was as loudly praised as heartily denounced. A year ago, still, a Catholic writer compared Vogt to a "murderer" for having written it, and so clearly spoken out his materialistic creed. There is no doubt as to Vogt's sincerity, but doubt may be entertained as to the necessity of some pages in his otherwise very interesting and spirited book. "The philosopher must station himself in the middle," said Goethe. Vogt was by nature extreme. On the other hand, it must be confessed that the much-abused sentence, "Thought is about in the same relation to brain, as bile to liver, or urine to kidney," is one that no physiologist can refuse to endorse, as long as he stands only on the solid ground of facts as at present ascertained.

To the same period of life belongs "Ocean und Mittelmeer," a descriptive narrative of excursions to the seashore, mingled with scientific facts. During his summer vacations, Vogt travelled on the Mediterranean coast, and while the picturesque scenery and pleasant climate of the sun-bathed shores strongly appealed to the intense feeling of the lover of nature, the naturalist was attracted by the rich and varied fauna; he therefore decided, *hic et nunc*, to pursue his investigations; Nice was even better than Paris. Here was performed most of the work which ended in the publication of many papers on Cephalopods (with Vérany), on Siphonophora, and Ascidians. In 1846, kind Liebig, who had kept an attentive eye on his former pupil's doings, wrote to offer him a position. The Giessen University was to have a chair of Zoology; would he come and fill it? Certainly, answered Vogt. But there were difficulties. The Government was—for reasons of old, already told—no friend to the republican "Mutz," whose "Physiologische Briefe" were to many a permanent scandal; and Liebig's proposal would have been rejected, had it not been for old von Buch's and Humboldt's personal intervention. Agassiz also helped actively, and in 1847 Carl Vogt, the police-tracked student of 1837, entered Giessen as Professor of Zoology. It would seem that the *wanderjahre* were now over, and that the hot-headed young man was to settle down quietly in his chair, to grow fat and bald, and conservative, and optimistically smile upon the world, sitting down and doing nothing, or little. Such is often the case; but with Vogt, otherwise.

His first act was a scandal to the peaceful community of Giessen: he refused to shave, as university professors were required to. And then, 1848 was approaching; the storm was brewing, and how could Vogt not be attracted by the prospective trouble? A member of the dissolved *Vorparlament*—all this story cannot be abridged, so it is simply omitted—Carl Vogt was re-elected as antagonistic to the Conservative Government, and during a few days he was one of the *Reichs-regents*—part of an emperor. But the republicans were crushed by superior forces, and the revolution was checked. Vogt had to take leave—his chair was handed over to Rudolph Leuckart—and he sought a refuge in Switzerland, and shortly after in Nice. Politics were, for the time being, dismissed, and zoology again carried the day. At least, *Bilder aus dem Thierleben*, and papers on different invertebrata of the coast, went to show so much, followed by *Untersuchungen über Thierstaaten;* but even here, Vogt managed to

intersperse political allusions in biological descriptions: an unnecessary feature, to speak the truth. His innate aggressiveness had again the best of him. A year or two passed, when he received from Geneva the proposal of a botanical chair. Vogt, not feeling qualified, declined. Well, would he accept a chair of Geology and Palæontology? Willingly: and now, at last, Vogt "settled." He became a Swiss citizen, and from 1856 to the day of his death, played a not unimportant *rôle* in Swiss politics, having been repeatedly elected to the highest councils of State. He was one of the founders of the *Institut National Genevois*, and while duly attending to his professorial duties, he took an active part in the more important political and scientific discussions or quarrels of the time. He was one of those who before the sixties, ardently advocated the creation of zoological marine stations; nor could he fail, when the "Origin of Species" was thrown on the world, to become an admirer and supporter of the new theory. The principal events of his life may now be rapidly noticed. In 1861, he travelled north and visited Norway, Jan Mayen, Iceland, publishing an account of his excursion in 1862 under the title "Nord-Fahrt entlang der Norwegischen küste," &c.; in 1863, were published "Vorlesungen uber den Menschen"—translated in English, French, Italian, Spanish, Russian, Polish, Hungarian—much read, much abused, but also much approved in spite—or because—of the burning ground which they covered; and the interest Vogt took there and then in prehistoric archæology was the cause of his investigations on anthropology, later embodied in different papers: "Ueber die fossilen Menschenschädel der Diluvialbildung," "La Machoire humaine de Naulette," "Le Crane du val d'Arno." His "Vorlesungen über schädliche und nützliche Thiere" were published at about the same time. In 1865-66 he issued his important "Mémoire sur les microcéphales ou Hommes-Singes," where he considered microcephaly as a return to the condition of man's ancestor—a view much opposed by Virchow, while no definite conclusion can be said to have yet obtained. From 1867 or 1869 he wrote little, but spoke much. At that time he travelled in Germany delivering lectures on the origin of man and the Darwinian theory. "Affenvogt"—monkey-Vogt, as he was nicknamed by the people, had occasionally a hard time of it. One evening, while he was lecturing, some stones crashed through the window. "I was talking yesterday evening, gentlemen," says Vogt, picking up one of the missiles, "I was talking of our savage ancestors of the Stone age: you may perceive now, that this age is not entirely a thing of the past." And Broca, writing to him about his book on useful and injurious animals, could rightly say: "Vogt, there are many beasts in this world and of the most injurious, of which you have said nothing." . . .

Vogt's life is so very full, that it is hard to even mention its principal phases. In 1872-74 we find him actively engaged in the task of creating a medical school—a university—in Geneva, and in 1875 he succeeds, having played a very prominent part therein; at the same time he publishes his "Atlas der Zoologie," translates Gegenbaur's "Manual of Comparative Anatomy"; writes papers for a number of reviews; works at Roscoff at his "Loxosoma" and "Recherches Cotières;" and has a good fight with anti-vivisectionists. In 1879, he comes forward again with a paper on "Archæopteryx"—the second skeleton discovered. In 1884, he publishes his large book on "Mammals," illustrated by Specht; and then sets to work at his "Traité d'Anatomie comparée," with E. Yung's co-operation. A large work, and one that entailed much effort—this treatise was completed only two years ago—it was Vogt's *chant du cygne*, the last work of a very complete and active life, and one which fittingly crowned and closed his career. Carl Vogt was spared the *ante-mortem* death which too often preys upon brain-workers, and kept his mental vigour to the end.

Ever liberal in spirit and in doings, he was to the last the champion of liberal measures and laws, and the protector of the oppressed. Scientific men may regret that he did not devote more time to pure science, but he has so much contributed to ventilate the *quæstiones vexatas* of his time, and to render them intelligible to the general public; he has so liberally devoted much of his time, activity, and talent to the furtherance of measures favourable to the benefit of all, that this regret must cease to exist. Doubtless, he was often excessive in language, and his undisguised materialism made him a large number of enemies. The latter cannot fail, however, to recognise the fact that the life of this "infidel" has been one of which no orthodox man could be ashamed, and that the guiding motives of Carl Vogt's thoughts, writings, and acts were generous and elevated.

M. William Vogt's account of his father's life is most interesting, and we have not been able to do it justice in so short an account. The son has inherited much of his father's wit and hot-headedness; he writes in picturesque and not over-academical style. Some letters of Vogt's correspondents are interspersed here and there: letters from von Baer, Bunsen, de Candolle, Darwin, Gaudry, Herzen, de Quatrefages, Sir John Lubbock, Lyell, &c.; but we much regret that there are not more of those of Carl Vogt himself. The large, powerful, lion-headed naturalist had not only power at his command; wit he had also, and he knew how to use it. The slender and piercing arrow he let fly as dexterously as he wielded the sword or the battle-axe. Many still live who could testify thereto.

HENRY DE VARIGNY.

THE EASTERN TIAN-SHAN.

Description of a Journey to Western China. By G. E. Grum Grzimailo, with the aid of M. E. Grum Grzimailo. Vol. I.: Along the Eastern Tian-Shan. With map and thirty engravings. Edited by the Russian Geographical Society. In Russian. 4to. pp. 320. (St. Petersburg, 1896.)

UNDER the above title the Russian Geographical Society has issued a new addition to its splendid series of works on Central Asia, which already contains the records of the journeys of Prjevalsky, Potanin, and Pyevtsoff. The yet so little-known mountains which are described under the vague name of Eastern Tian-shan, the great desert of the Hashuñ Gobi, and the Nan-shan highlands having been the field of exploration by the brothers Grum Grzimailo during the years 1889 and 1890,

the present volume contains the records of the first year's journey along both slopes of the Tian-shan, in the oases of Guchen, Hami and Turfan. Starting from the Russian Turkestan town, Jarkent, the expedition went first to Kulj a, whence they crossed the Eastern Tian-shan, named Boro-khoro in that portion of it. To do this, they went up the steep and 8500 feet high Tsiterty, or Achal Pass, from which most beautiful views open on Lake Ebi-nor, and where the chain falls most abruptly northwards to the sandy deserts surrounding the now rapidly desiccating lake, whose altitude is only 700 feet. Then the explorers made a series of unsuccessful attempts at recrossing the Boro-khoro Mountains from north to south. Although the Torgoutes, and next the Chinese, tried to dissuade them from such a venture, they went, nevertheless, up one of the tributaries of Lake Ebi-nor, but were soon compelled to return. In their middle courses, the streams which flow from the great chain run through remarkable cañons deeply cut in diluvial deposits, and in their upper courses the cañons become mere rents between high cliffs, through which the water, rapidly rising from the melted snow, rushes as a torrent. Compelled to return, the party explored the northern spurs of the Borokhoro, vainly looking for another pass, as they slowly moved east, towards the oases of Manas and Urumchi. From this last oasis they visited the beautiful group of the snow-clad holy mountains, Bogdo-ola, which raise their peaks above a picturesque alpine lake. One fully realises, on reading the travellers' description of these forest-clad mountains, covered with glaciers, and intersected with cool alpine valleys, while barren deserts surround them, why they are so much venerated by the Mongols and considered as the seat of deity.

From the next oasis, Guchen, the party made an incursion into the sandy Dzungarian desert, and there secured at last, with no little difficulty, two specimens of the Wild Horse (*Equus przewalskii*, Poljakoff), for which Prjevalsky had vainly hunted on his last journeys. The pages given to this hunt read like a novel—so difficult and exciting was the killing of two of these cautious animals, out of a herd of seven individuals who came at night to drink in a small salt lake, and whose security was most vigilantly watched by an old male.

The first specimen secured was about ten years old. The wild horse has something in common with the Altai, Caucasian, and Finnish ponies: it is of a short stature (1·46 metre high), and has a broad chest and back, a short, massive neck, and fine legs, as elegant as those of the race-horses, ending with broad hoofs. The head seems rather heavy in comparison to the body, but the wide forehead is handsome; the line from the forehead to the nose is straight, and the upper lip covers the lower lip. The tail, whose upper part has the colour of the body, while its point is black, is longer than the tail of the wild ass, but it is not entirely covered with hair. The mane begins in front of the ears, the longest hairs being in its middle part. In the scantiness of hair, the wild horse has also something in common with the Tekke Turcomane horse; but the killed specimen had a strange-looking pair of hard whiskers, about four centimetres long, running from the ears to the chin. The wild horse has a sandy colour in summer, and light brown in winter, with nearly white parts on the abdomen; the forehead and cheeks are darker than the remainder of the body, while the end of the snout is whitish. The legs and the mane (which hangs to the left) are black; the spinal mark hardly exists, and disappears in winter. As a rule the hair is short and glossy, but somewhat curly in the foals. A good photograph of the killed horse, in profile, is given by M. Grum Grzimailo.

The manners of life of the wild horse differ from those of the wild asses—the *djighetais* and the *kulans*. They stay, in preference, in the deserts, while the latter prefer the mountain regions. They march in Indian file when they feel danger, and leave in the desert their traces in the shape of well-marked paths, as they march from their retired abodes amidst the desert hillocks to their drinking-places. They neigh exactly as our horses, while the wild asses only bray, and they have the characteristic growling of our horses. The Mongols sometimes succeed in catching young foals, but they never could tame them.

From Guchen the expedition went to Hami and Turfan, the most important centre of the region, and the work under review contains very valuable data relative to the inhabitants of these two oases. From Turfan they moved southwards, exploring the Bei-shan mountains, and coming to several interesting conclusions concerning the relations between the Tian-shan and the southern highlands, which relations will be treated more fully in the next volume. In the south of Turfan they made the remarkable discovery of the Assa depression, near Lukchun, where the barometer stood so high that, on comparing its heights with the isobars for the corresponding days in other parts of Central Asia, General Tillo concluded that the level of this depression is about 170 feet *below* the level of the ocean. The two years' barometrical observations, subsequently made by one of the members of Roborovsky's expedition, have fully confirmed the above conclusion.

A map of the region, on a scale of twenty-seven miles to the inch, accompanies the work; and certain photographs—namely, of the Bogdo-ola lake and mountains, the wild horse, and the inhabitants of the oases—are very interesting. A list of the birds brought in by the expedition, which were described by F. D. Pleske in the *Mélanges Biologiques* of the St. Petersburg Academy of Sciences (vol. xiii.), as well as a list of the Lepidopteræ collected by the author, complete the volume. Other valuable collections are still in the hands of specialists.

P. K.

OUR BOOK SHELF.

Navigation and Nautical Astronomy. By F. C. Stebbing, Chaplain and Naval Instructor, Royal Navy. Pp. vii + 328. (London: Macmillan and Co., Ltd., 1896.)

Mr. Stebbing's "Navigation and Nautical Astronomy" is the most satisfactory treatise on the subject we have yet seen. The author's experience, as a man of university attainments, a naval instructor afloat, and Admiralty examiner at Greenwich, has enabled him to produce a book that meets the practical and theoretical requirements of the modern navigator without being overladen with perplexing disquisitions or elaborate and unnecessary formulæ.

The works we have hitherto come across generally run into one extreme or the other. The first group, of which

we may take Raper's as a type, consists of excellent practical examples and methods, but is so deficient in explanation and theory that a student could not obtain any grasp of the principles involved without the assistance of some friendly tutor. This is a serious objection if we consider the need of amended methods to meet the present increased speed of ocean transit and the consequent emergencies.

The other group, following on French lines, is so lumbered with investigations of a high mathematical order as to be quite beyond the comprehension of the average sailor.

Jean, who made an attempt to combine the two, produced two volumes of good matter, but ill-arranged and cumbersome. He has, in addition to the versine method, five difficult and different ways of "clearing the lunar distance."

We are glad to see that Mr. Stebbing has taken to heart the fable of the cat and the fox, and in every astronomical problem has selected the method in general use among the advanced school, and has explained and solved his problem by that method, and that only. His book is therefore of modest dimensions, and any student of average intelligence can read it and comprehend it unaided.

The comparatively small number of first-class navigating officers is in itself a conclusive proof that the art of navigation is much more intricate than a casual run through the subject would lead us to suppose. Long experience and special advantages are necessary to graduate as an instructor in this branch of science, and we therefore all the more welcome Mr. Stebbing, who happens to possess these special requirements, as a guide to our sailors of the present and the future.

The Distribution of Rain over the British Isles during the Year 1895. Compiled by G. J. Symons, F.R.S., and H. Sowerby Wallis. Pp. 237. (London: Edward Stanford, 1896.)

MR. SYMONS'S staff of voluntary observers now numbers 3084, having grown from 168 in the year 1860. Of these observers, 2304 have their stations in England, and only 398 in Scotland—a disproportion which is to be regretted. The large number of private stations where good records of rainfall are kept, is a striking testimony to the interest taken in local meteorology.

The present report contains an interesting article on Seathwaite as a rainfall station. The first systematic records of the rainfall at that place were made in 1845, so the station attained its jubilee in 1894. The following conclusions concerning this very wet spot are stated by Mr. Symons: (1) The rainfall at Seathwaite is on the average 135 inches a year. (2) In the wettest year it has exceeded 182 inches, and may possibly reach 190 inches. (3) In the driest year it has fallen to 88 inches, and will probably never be less. (4) In one month (November 1861) more than 35 inches fell. (5) In September 1894, very little more than half an inch fell. (6) There are nine recorded cases of more than six inches falling on one day—probably there have been about a dozen—the heaviest recorded was 7·52 inches on November 26, 1861.

Several plates illustrating Seathwaite, and the positions and patterns of the rain gauges, accompany the article.

In another article in the present volume systematic percolation experiments carried on at Apsley Mills, Hemel Hempstead, are described and discussed. Gauges were sunk in sand, chalk and earth, to measure the percolation at depths of 3 feet and 5 feet in each case. The result of the whole of the observations is, with a probable error of less than 2 per cent., "that with a rainfall of 26 inches, 16 inches percolate through 5 feet of sand, and 10 inches are evaporated from it; and that 12 inches soak through 5 feet of chalk or earth, and the other 14 inches either evaporate or run off the surface." The differences between the results obtained by the gauges at 3 feet and 5 feet were very small. The loss by evaporation is found by Mr. Symons to follow very nearly the same monthly variation as that from a water surface, but is decidedly less.

There are several other articles on various branches of rainfall work, and they help to make the new issue of "British Rainfall" an interesting volume.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Total Solar Eclipse of August 9, 1896, as observed in a Cloudless Sky at Bodö.

As Bodö was considered as offering conditions not favourable for serious work, this pretty town, so easily accessible for the greater number of European astronomers, was left unprovided with any astronomical instrument. And yet that town was, during the eclipse, favoured by a cloudless sky, which could have given magnificent results. I had the good fortune to observe there the wonderful phenomenon, and to make (what was chiefly my purpose) a sketch of the general outline and the rays of the corona. I do not think that among the thousands of Norwegians who witnessed that grand spectacle there were more than twenty foreigners, almost all English and American ladies and gentlemen.

The place we selected was on a hill at Brevig on the Saltenfjord, near Bodö, which hill had been found on May 3, when the sun was as high as on August 9, to be well situated for the eclipse observation. The weather on the previous days had been fine and very promising, and on the night of August 9 was even more splendid than before. On seeing the sun rise wholly clear from behind the mountains, no trace of the smallest cloud spoiling the clearness of the sky, an enthusiastic "hurrah!" arose from the numerous gathering on the hill.

Two minutes past 4 o'clock we first saw that the sun's edge, in the northern hemisphere and on the right-hand side, was hidden by the moon. Little by little the sun's disc was covered more and more, but the amount of light did not sensibly diminish until more than three-fourths of the disc were obscured. The darkness gradually increased, for the moment of the total eclipse was approaching. How slowly the seconds seemed now to pass, and how quickly after the first moment of totality! That impressive moment occurred at 4.54. Then at once we saw the moon of almost inky darkness encircled by the white corona. The corona was not at all regular. Its most peculiar feature was the total absence of any ray or streamer in the vicinity ($\pm 25°$ W. and E.) of the sun's North Pole. Over the South Pole the corona was also a little less extensive than in the middle latitudes, where the greatest accumulations were to be seen in two enormous wings on both sides of the dark, empty space over the North Pole. The only colour I observed was the pink colour of the chromosphere around the edge of the moon (and less, also, at the sun's North Pole). In the chromosphere a few points (especially one at the left-hand, a little south from the equator) were blazing with dazzling brightness. Although the sudden apparition of Jupiter, Venus and Mercury, and, according to some observers, also of a star in the constellation Gemini, was very impressive, the darkness was not so great as I had expected, and did not hinder me in the least in beginning the sketch, which—not for want of light, but for want of the necessary calm of mind—I could only finish when all totality was over. The moments were too short and precious. I looked also an instant at the water in the fjord, and the snow-mountains on my left hand. The fjord was dull grey, the mountains pink at the bottom, and more yellowish at the top. The grass on our hill was dark olive-green.

At $4.55\frac{1}{2}$ the sudden blazing up of a white point, quickly growing to a crescent at the right-hand side of the sun, proved that totality was over. At the first glimpse of sunlight, corona, chromosphere, and planets ceased to be visible to me.

Till 5.50 the sun remained partially eclipsed. Thus we observed the sun on our steamer *Ofoden*, while returning to Bodö. But who could imagine our surprise, and the increase in our gratitude for the splendid conditions in which we had seen the eclipse, when, twenty minutes after totality was over, we saw the sky everywhere, and especially also at the sun's side, covered with heavy clouds! It was as if these clouds had been caused by some cooling effect of the eclipse. A. BRESTER, JR.

Delft, Holland, August 23.

Air Temperature during the Solar Eclipse.

SOME observations of air temperature, which I was able to make at Vadsö during the solar eclipse on August 9, are perhaps worthy of being put on record. I observed on the plateau or flat-topped hill north of the town of Vadsö, a few minutes' walk beyond Prof. Copeland's station, and at the height of 400 feet above the sea, by aneroid. None of the astronomical observers occupied quite such a high position. It was chosen in order to escape the disturbing effect of air-currents on the hill-side sloping to the fjord. The thermometer was provided with a small bulb, and hung from the tripod of a 3-inch telescope, the bulb being about 18 inches from the ground. No special precautions were taken to shield it from the sun's rays; unfortunately, they were not necessary. A light northerly breeze was blowing, and the sky was heavily clouded.

Speaking roughly, the eclipse began at 4, was total at 5, and was over by 6 o'clock. At 4.8 and at 4.18 the temperature was 44·0° F.; at 4.23, it was 43·5°; at 4.28 and 4.33, 43·2°. From 4.35 to 4.43 the sun was shining brightly, and the temperature rose to 43·3°; at 4.53 and 4.59, glimpses of the sun were caught before and after totality. The temperature from 4.48 to 4.58 was steady at 43·0°; at 5.0, it had dropped to 42·1°; from 5.3 to 5.13 it stood at 42·3°. By 5.33 it had risen to 43·8°, and at 5.48, when I ceased observing, to 45·0°.

The suddenness of the fall at, or rather immediately after, totality is very marked, the depression amounting altogether to 1·9° F. from the commencement of the eclipse, and the subsequent rise being equal to 2·9° F. to the end of the eclipse.

1 Savile Row, W., August 24. HUGH ROBERT MILL.

The Position of Science at Oxford.

YOUR correspondent "W. E. P." shows a curious ability for injuring his own side. He says that "Oxford collectively has done her best to remove any inferiority she may have had in the past" in respect of her scientific school, and further, "it would be difficult to name a body better qualified to decide what is a good general education than Convocation itself." And yet the whole tone of his letter is a practical confession that Oxford has failed in her best attempt, and that her view of general education has resulted in a practical failure to forward an essential branch of general education. The fact is Oxford's best is bad, and her ideal education is one-sided. The most serious cause of complaint of modern society against the old universities is that they have so controlled the education of the wealthy classes of the community that the landed and professional classes have been educated apart from the commercial and industrial classes to the very great injury of both. One might as well consult a committee of clergy as to the best education for a doctor, as advise with university dons as to the best education for the general community. The influence of a Pagan civilisation has created in them an ideal of life founded on contemplative learning, rather than on a Christian benevolent activity.

GEO. FRAS. FITZGERALD.

Trinity College, Dublin, August 19.

On the Notation of Terrestrial Magnetic Quantities.

AT the International Meteorological Congress to be held in Paris, a number of questions of special interest to magneticians have been proposed for discussion, among which is the following:—"The same notation should be generally employed, *H* for horizontal force, *X* for the northern component, *Y* for the western component, *Z* for the vertical force, and *V* for the potential." As the need of some uniform notation has been made apparent to me in connection with the journal *Terrestrial Magnetism*, I have been paying this matter some attention with the view of obtaining a concise and logical system for adoption in that journal.

The principle upon which I proceed is to take the first letter of a word designating a particular quantity, if at the same time it conforms with typographic requirements, such, for example, as declination, which is common to several languages. In this way I have thus far obtained the following: *D* for declination, *I* for inclination, *H* for horizontal component of force, *V* for vertical component, *F* for total force. Upon examination it will be found that these letters stand for words derived, in almost all cases, originally from the Latin and Greek languages, and with but insignificant variations in spelling, common to several of the main modern languages.

The Germans will be asked to yield a point with regard to *F*,[1] but this, as will be seen below, will be made up to them in the adoption of *G* for magnetic potential. *V* taken from the Latin *vis*, or *I* from *intensitas*, or *D* from the Greek word δύναμις, would not do for force, as they are already taken. Nor would *T* from *totus* or *P* from πᾶς answer, since the former is frequently used for time of vibration, and so in fact is the letter *P*, which stands besides for the first deflection coefficient. As I hope to be able to find a satisfactory notation for all the principal magnetic quantities, I am keeping this matter constantly in mind in adopting any particular letter. The English and French have *force*, and I have, therefore, adopted *F* for total force. As it is frequently the custom to designate angular quantities by Greek letters, I should have preferred, had it been possible, to adopt δ and ι instead of *D* and *I*, but the Greek ι is a very unsatisfactory letter from a typographical standpoint. Moreover, if found desirable later on, the small letters *d* and *i* or δ and ι can be reserved for the variations on the mean of day and on the mean of year respectively.

I think it very much to be deplored if *Z*, as above proposed, be universally adopted to designate the vertical force. It should not be forgotten that the Gaussian mode of resolving the magnetic force into northerly component (*X*), westerly component (*Y*), and vertical component (*Z*), applies to a *local* system of coordinates, not to a *fixed* system, as the layman might naturally suppose—a fact which is even apparently forgotten at times by magneticians. The mean values of these components for a complete circuit of the earth along a parallel of latitude can, in consequence, no more be *physically* interpreted than the mean *H*, for example. I am, therefore, opposed to adopting for the vertical force a letter which in no way gives evidence of the exact quantity for which it stands. *V*, on the other hand, is logically connected with *H*, and at the same time implies that the direction of the quantity that it symbolises is *local*, the direction of the vertical or plumb-line varying from point to point.

For the same reasons I am not in favour of adopting *X* for northerly component, and *Y* for westerly component. Let authors choose this method of notation, if they prefer it; but in a system suggested for universal adoption, it would seem to me that *N* and *W* would more satisfactorily meet the requirements, clearly indicating to the eye as they do the local character of the system of coordinates employed.

As a letter to designate the earth's magnetic potential, I believe none more fitting could be adopted than *G*, after Gauss, the author of this function. Gauss himself used *V*, but this letter is not sufficiently characteristic; it is used to designate many other functions in mathematical physics; and there would, moreover, be a conflict in our system, since *V* seems the most logical letter to designate the vertical force. L. A. BAUER.

Linden, Montgomery County, Maryland, August 10.

On "Hullite."

THE authors of a paper just published in the *Transactions* of the Royal Irish Academy, which is certain to be widely read, have dealt at length with the material called "hullite," urging that it is, in reality, "a hydrous glass of low specific gravity."

This paper was read on June 10, 1895, but a "note added in press" concludes as follows:—

"An abstract of this paper was published in NATURE of June 27, 1895; since then I have received, by the kindness of Prof. Cole, a paper by him on 'hullite' [reference given, *Proc. Belfast Nat. Field Club*, 1894–5, p. 1]. It contains an interesting *résumé* of the literature of the subject, and describes, quite independently, the occurrence of 'hullite' as 'a true ground-

[1] The initial letter of the German word *Kraft* is frequently used to designate the moment of inertia, and hence will not answer for force.

work to the crystalline constituents' of the rock in which it occurs."

I should not have referred to the matter had not the date of publication in NATURE been quoted in a way that suggests a sort of challenge. It seems only fair to point out that my paper was read on March 19, 1895, and that the conclusion—that the material was "an altered basic glass"—was published in two places in the *Irish Naturalist* on May 1, 1895. The full paper appeared on July 1, 1895. The two investigations, to some extent supplementing one another, afford certainly a curious case of parallelism. GRENVILLE A. J. COLE.

Royal College of Science for Ireland, August 20.

Foreign Snails in the West Indies.

Two large living specimens of *Stenogyra* (*Rumina*) *decollata*, Linn., were recently found in the garden of Dr. W. J. Branch in St. Kitts. Though familiar with the land shells of the island, having lived and collected there for many years, Dr. Branch had never come across this shell before.

These had probably been introduced accidentally as young or eggs among European plants. Tryon states that the snail is naturalised in Charleston, South Carolina. It seems to have thrived in our garden, which is very tropical, but we cannot say yet that it is naturalised.

We have tried the introduction of foreign snails into this island. *Helix* (*Dentellaria*) *josephinæ*, Fér., from Barbados, did well in a garden, but since we changed our residence it seems to have disappeared. *Bulimus* (*Borus*) *oblongus*, Mull., introduced a few years ago, also from Barbados, thrives and multiplies, but has not, so far, gone beyond the garden. It would seem, then, that the chances are against the *Stenogyra* becoming fixed in St. Kitts. The fact of its chance occurrence is, however, worth recording. C. W. BRANCH.

St. Kitts, W.I., August 2.

THE ARCTIC RECORD OF 1896.

THE triumphal progress of Dr. Nansen and his companion, Lieut. Johansen, along the coast of Norway has been interrupted by the most striking coincidence ever known in Arctic travel—the appearance of his ship the *Fram*, with all her crew in good health, and with a record of northern latitude only less remarkable than that attained by Nansen himself. On the very day that Nansen sighted the coast of Norway, the *Fram* forced her way out of the ice-pack into the open sea.

It will be remembered that Dr. Nansen's expedition was based on a theory of polar ocean-currents. The map published in NATURE for May 17, 1894 (vol. l. p. 57) shows that a current or drift was supposed to set across the Arctic Sea from the neighbourhood of the New Siberian Islands to the coast of Greenland, passing within a few degrees of the North Pole. The strongest piece of evidence for the existence of such a current was the discovery off Julianehaab, in south-west Greenland, of certain relics believed to have drifted from the *Jeannette* after her loss near the New Siberian Islands. The authenticity of the *Jeannette* relics is still in dispute. A very elaborate criticism of the evidence concerning them was published, by Prof. W. H. Dall, in the *National Geographic Magazine* for 1896 (vol. vii. p. 93), which concluded with the opinion that the whole affair was a hoax. This was warmly contradicted by a powerful Committee of the Geographical Society of the Pacific, which wound up its report on May 9, 1896, with the words: "After carefully weighing these statements and recalling the mental and physical characteristics of Dr. Nansen and the brave comrades and men who cheerfully accompany him, and the special fitness of the *Fram* to encounter ice dangers, the Committee places upon record its convictions—that the present expedition was fully warranted, and that it will return successful." A month ago these arguments were the only data on which to found an opinion as to Nansen's fate; and I was astonished to find how pessimistic were the views entertained by well-informed Norwegians, some of whom laughed heartily at me off the Nordkyn on August 10 for turning my glass on the northern horizon on the chance of sighting the *Fram*, which they believed to have been long ago crushed in the ice, and her crew perished. The unfavourable views expressed by our leading Arctic authorities on Dr. Nansen's scheme of pushing his ship into the ice and allowing her to drift with it, and on his plan of building his vessel so that she should be forced out of the ice instead of being crushed by it in case of being nipped, were loudly expressed, but they are also, fortunately fallacious. The new scheme, founded on a carefully considered hypothesis, has proved completely successful, in spite of its opposition to all the maxims of polar experience and the demands of traditional prudence.

NATURE published last week the very full telegraphic data, obtained by the *Daily Chronicle*, as to the main points of this most successful of all polar expeditions. These should suffice to satisfy public curiosity until the intrepid explorer is able to give a personal account of his work. The fact that the pole was not reached is unimportant, for it is conclusively proved that the pole may be reached with comparative ease by good ski runners, aided by a sufficiency of dogs. The additional news brought by the *Fram*, throws a good deal of new light on Arctic geography. As reported in the *Daily Chronicle's* telegram from Skjervö on August 21 and 25, the general course of the vessel was exactly that predicted by Nansen when he quitted her, viz. westward round the north of Franz Josef Land. She was left under the command of Captain Sverdrup on March 14, 1895, in 83° 59′ N., 102° 27′ E., embedded in the drifting ice about 450 miles north of Cape Chelyuskin, and 400 miles east of Franz Josef Land. By the end of February 1896, she had reached 84° 9′ N. and 15° E., a drift of 600 miles, which brought her to a point about 280 miles north of Spitzbergen. Parry in 1827 had reached 82 45′ on the same meridian by sledging over the floe until he was stopped by the rapid southerly drift of the ice. While north of Franz Josef Land the *Fram* reached its highest latitude, 85° 57′, only about 20 miles short of that attained on Dr. Nansen's sledge journey, viz. 86° 14′. Had it been possible to dispatch a sledge party from this point, the pole would most probably have been attained. From July 19 to August 12 the *Fram* was working her way out of the ice by her steam power; then gaining open water, she reached Skjervö on August 21. The minimum temperature observed was $-52°$ C., the maximum only 3° C. Neither land nor icebergs were seen, only an expanse of hummocky floe ice unbroken by any considerable stretches of open water. The ice grew to about 13 feet in thickness, and the sea ranged in depth from 1800 to 2200 fathoms.

Sir George Baden-Powell was fortunate enough to receive Dr. and Mrs. Nansen on his yacht the *Otaria* at Hammerfest, and to have the satisfaction of taking them to meet the *Fram*, with which they will probably proceed to Christiania. The enthusiasm of the Norwegian people over Dr. Nansen's success and safe return was beginning to be touched with anxiety for the fate of his equally courageous companions, which this happy reunion has effectually banished.

Until the voluminous observations bearing on almost all branches of science have been fully discussed, the true value of the results of the expedition cannot of course be known. Even now, however, some important facts are plain. Franz Josef Land is only a group of islands possibly smaller than Spitzbergen, and it does not afford the dry land highway to the pole to which at one time it was hoped to be the doorway. The absence of icebergs practically proves the absence of any extensive land in the track of the current, although it may be that the drift of the *Fram* being towards the east and not the west of Greenland, indicates the existence of a land barrier near the pole, or on the American side of it. The dream of an open polar sea must be abandoned for

ever. One of the most interesting results so far announced is the great depth of the Arctic Sea over a very large area. This accentuates the physical contrast between the Arctic and the Antarctic regions; and will probably make it necessary to adopt a greater mean depth for the ocean, and a deeper position for the line of mean-sphere level (*cf.* NATURE, vol. liv. p. 112). The general course of the *Fram*, as sketched from the provisional data, shows an altogether remarkable parallelism with Dr. Nansen's hypothetical track of the *Jeannette* relics, and fully bears out his theory of the circulation of the Arctic Sea. A "palæocrystic sea" would appear to be possible only in conditions which give rise to eddies, or otherwise impede the normal circulation. The temperature has not been found so low as that frequently experienced in northern Siberia, so that unendurable cold can no longer be viewed as an obstacle in the way of making high latitudes.

So far as high latitudes go, Admiral Markham, in 1874, succeeded in passing Parry's position of 1827 by only 35′, or about forty miles; Lockwood, in 1882, did not get more than four miles further north than Markham; but Nansen has taken the unexampled stride of 2° 50′, or almost two hundred miles beyond the previous "record," in consequence of his simple plan of not opposing, but siding with the workings of nature. The result is a triumph of science, and a proof—if proof were needed—that scientific training, no less than courage, perseverance, and physical endurance, is necessary in a great explorer.

Apart from the voyage of the *Fram*, this summer has yielded a rich harvest of arctic exploration. The *Windward*, which left Vardö on June 29, under the command of Captain Brown, an experienced whaler, and with the aid of Mr. Crowther as ice-master, has made a remarkably quick voyage to and from Franz Josef Land. She took out Mr. W. S. Bruce and another member of Mr. Jackson's party, and brought back several whose time with the expedition had expired. The telegrams which have been received show that Mr. Jackson's party have passed the winter comfortably, and have had excellent sport; they have devoted themselves to the mapping of the region around their winter quarters, and dispatches are promised by the *Windward*, which will doubtless give particulars as to points visited and positions attained. Dr. Nansen's journey on the ice north of Franz Josef Land will be a powerful stimulus which should result in great achievements.

Mr. Andrée's balloon expedition has had to be postponed on account of delay in getting the balloon-house erected and the balloon filled, but it will certainly be renewed next year. Spitzbergen, with weekly mail-steamers, a comfortable hotel, and even a set of postage-stamps, has been largely visited by tourists during the summer; but amongst the sight-seers and sportsmen there have been several scientific men bent on serious exploration. Sir Martin Conway, with Dr. Gregory, Mr. Garwood, and Mr. Trevor Battye, have been over a large amount of new ground, and made several interesting discoveries. The geology of the islands in particular has been carefully worked up, and the results will be looked forward to with confidence. The whole party has safely returned to Norway.

Mr. Peary's expedition to the north-west coast of Greenland has been much hampered by the ice, and it is uncertain whether it will yield any scientific results. The application of the name *Peary-land* to the extreme north of Greenland, proposed by the Geographical Club of Philadelphia, has been generally approved as a tribute due to an explorer of great power and perseverance.

Prospects of Antarctic exploration are no brighter. The Belgian expedition has been postponed, and the English expedition to Cape Adare does not seem likely to start this year. There is, however, a possibility that the wave of enthusiasm in polar research, which is sure to pass over Europe during the coming winter, may float some of the existing schemes, or even move high quarters, and lead to the dispatch of a properly equipped Government expedition. However glad we should be to see a British party regaining the national prestige in the polar regions, the need for scientific research in those quarters would lead us to welcome the first who comes forward with a sane plan and a sound party, be their nationality what it may. The drift of the *Fram* has shown that the new explorer may succeed, even though he may contravene every law laid down by the old, provided he respects the law of nature of moving in the direction of least resistance, and not trying to hurry through in a season what should be the deliberate progress of years. May it not be possible that we have somewhat overestimated the necessity for naval discipline, and undervalued the power of scientific enthusiasm in polar exploration?

HUGH ROBERT MILL.

SIR WILLIAM ROBERT GROVE.

"I HAVE long held an opinion almost amounting to conviction, in common I believe with many other lovers of natural knowledge, that the various forms under which the forces of matter are made manifest have one common origin; or in other words are so directly related and mutually dependent that they are convertible, as it were, into one another, and possess equivalents of power in their action. In modern times the proofs of their convertibility have been accumulated to a very considerable extent, and a commencement made of the determination of their equivalent forces."

Thus wrote Faraday in 1845, beginning his paper "On the Magnetization of a Ray of Light and the Illumination of Magnetic Lines of Force," and the words describe admirably the subject of William Grove's great work "On the Correlation of the Physical Forces" which appeared in the following year. But as a matter of fact this famous essay had been brought into existence three years before as a course of lectures delivered at the London Institution, in which Grove then held the post of Professor of Experimental Philosophy. It was the first systematic statement of the connections between the different departments of physical phenomena, and as such was of great scientific (that is *science-making*) value. Helmholtz's magnificent exposition of the principle of conservation of energy appeared the year after, and contained as completely as was then possible that quantitative discussion referred to in the last words of the above quotation from Faraday, as being when they were written, at various points begun. These two remarkable essays may be said to form the starting-point of the modern science of energetics, of which the experimental foundation was even then being overhauled and laid still more deeply and stably by Joule. If we reflect how much has come from the principle of constancy of energy with the necessary aid of other dynamical principles (for the theory of conservation is by itself insufficient for the determination of the mode of action of physical forces), we are better able to form an idea of the value of the work done by these pioneers in exploring and mapping out the paths which appeared to lead from one province of science to another.

At the time of the publication of his essay Grove was about thirty-five years of age, having been born at Swansea in 1811. He had already accomplished a considerable amount of original work of great value. His voltaic cell, known now to all who have even the slightest knowledge of electricity, was one of several voltaic combinations which he devised, and was described first at the British Association meeting at Birmingham in 1839, and again in a paper in the *Philosophical Magazine* for October of the same year. Though the Grove battery is now superseded in most of our laboratories by dynamos, it was in

its day a discovery of no slight scientific importance. It solved in a very satisfactory way for practical purposes of experimenting the problem of how to obtain a voltaic battery of high electromotive force and moderate resistance, free from the paralysing effects of polarization when used to generate large currents for fairly long intervals of time. The battery soon became a great favourite for experiments involving heavy currents, such as the production of the electric light by means of an arc between carbon points; and it was that used by Faraday in his electro-optic experiments.

From the age of twenty-five to fifty Mr. Grove, though pursuing the profession of the Law, was actively engaged in scientific work, and at a comparatively early age was elected a Fellow of the Royal Society. Just fifty years ago he was awarded a Royal medal for his paper "On Certain Phenomena of Voltaic Ignition and the Decomposition of Water into its Constituent Gases by Heat," which formed the Bakerian Lecture for 1846. His papers are numerous and deal mainly with the phenomena of the voltaic cell, and of electrolytic decomposition generally. The subject of the polarization of gases in particular occupied much of his attention, and he discovered the well-known gas-cell, so interesting from a theoretical point of view, and especially now as being the forerunner of the modern secondary battery. Besides these Mr. Grove studied electrical discharge, the effect of light on polarised electrodes, and other subjects which, investigated with the aid of modern appliances and instruments, have yielded a rich harvest of valuable results.

The most active part of Mr. Grove's scientific career may be said to have ended about the time of his presidency of the British Association at the Nottingham meeting in 1866. His presidential address was on his favourite subject "The Continuity of Natural Phenomena," and he had then the satisfaction of finding the views he so early held now shared by all scientific workers, and illustrated by a great mass of recent scientific discovery. In 1871 he was made a Judge, and shortly afterwards received the dignity of knighthood. In 1875 the honorary degree of D.C.L. was conferred on him by the University of Oxford, and was followed in 1879 by that of LL.D. from the University of Cambridge. For sixteen years he devoted himself unremittingly to his legal duties, but in 1887, when he retired from the Bench, his former scientific interests and activity, never extinct by any means, in great measure returned. But at his now very advanced age arduous scientific work was impossible, and his contributions to scientific literature were limited to such lectures and addresses as his strength enabled him to deliver.

In the preface of his essay on the Correlation of Physical Forces, Sir Wiliam Grove represented himself as standing on the vantage ground obtained by the labours of others, and therefore as able perhaps to see somewhat further than those who had gone before. It is ever thus: the men of to-day work more surely and swiftly because such men as he have lived and worked before them. It has been given to few to witness, as did Sir William Grove, almost all the scientific progress of the nineteenth century, and it must have well rewarded his scientific spirit to see the younger generation enter into the labours of the founders of the theory of energy with so much eagerness and so great a promise of fruitful achievement.

A. GRAY.

PROFESSOR HUBERT A. NEWTON.

AT the time when the attention of astronomers is again directed to the return of the nucleus of the November meteors, the sad intelligence reaches us of the death of Prof. Newton, of Yale College, whose reputation is largely connected with the history of this shower, and who, perhaps more than any other, has advanced the position of meteoric astronomy to that it now holds. He thus rendered a great service to astronomy, and had he no other claims to remembrance this would ensure a grateful recollection. Prior to his historical researches the observation of meteors possessed but a languid and feeble interest, lacking that coherence and purpose which method, founded on a suggestive hypothesis, alone can give. The collection and discussion of the original accounts of thirteen meteoric displays, all of a similar description, and distributed over a period of more than nine hundred years, demonstrated the permanent character of the phenomenon, rendered prediction possible, and invited hopeful inquiry. The fact that he left the inquiry incomplete scarcely diminishes the extent of his service, since he showed that the problem came within the range of celestial dynamics, and he at once indicated the method and supplied the means which it was certain would be effective in the hands of a master of profound and subtle analysis. It is not necessary to pursue the subject further, or to more than mention the interest subsequently added to meteoric inquiry by the discovery of Schiaparelli and others working in this fruitful field; the impulse had been given, and the subject of shooting-stars became vividly and permanently a subject of astronomical notice.

Prof. Newton's connection with the observatory of Yale University has been long and honourable. Perhaps one is not quite justified in calling him the Director of the Yale Observatory, but his position seems rather difficult to define as the Secretary to the Board of Managers, who annually present a report to the President and Fellows of Yale College. For two years, 1882–4, he certainly held the position of Director; but he seems to have preferred his old position of Secretary, leaving the head of each department to make a separate report. There can be no doubt, however, but that his was the directing mind, and determined the character of the observatory. It was while he held the position of titular chief that the heliometer, which in the trained hands of Dr. Elkin has proved itself of such value, was mounted, and probably it was his suggestion that the observatory should possess an instrument of exact measurement rather than one of those gigantic equatorials, which elsewhere in America have appealed to the fancy, and satisfied the ambition of the millionaire. Certainly he subscribed liberally to the guarantee fund which ensured its use by a skilled astronomer, and the work that has issued from the observatory under his management, whether it be parallactic inquiry or stellar triangulation, has amply justified the expenditure, and placed the institution in the front rank of those devoted to extra-meridianal work. Not but that the utilitarian side of astronomy has also been ardently pursued at Yale. The distribution of time signals, the testing of chronometers and philosophic apparatus have long been a part of the routine work, and the observatory has worthily striven to maintain a high standard of workmanship.

Prof. Newton's services to science are by no means exhausted by the fulfilment of the duties of his chair or of the direction of the observatory. He has held the post of President of the American Association for the Advancement of Science, and been the author of many papers, generally connected with meteoric or cometary astronomy. More particularly may be mentioned his inquiry into the capture of comets by Jupiter or other planets, in which he has shown that the perturbing action of the planets on parabolic orbits of every possible inclination to the ecliptic tends to produce elliptic orbits of short period, moderately inclined to the ecliptic and with direct motion.

The Royal Society recognised the eminent services Prof. Newton had rendered to astronomy by placing his name on the roll of foreign members in 1892.

W. E. P

THE ECLIPSE OF THE SUN.

KIÖ ISLAND, BRAS HAVN,
Thursday, August 6, 1896.

BEFORE I attempt to give an account of what we have done here and of the local conditions generally, it may be well to state what, in my opinion at all events, is the most important work to be done at eclipses in the present state of our knowledge.

In looking back along the eclipse records, say till 1870, it is not a little surprising to note how the attack has varied in the importance attributed to certain of the inquiries; and how often it has happened that the chief scientific result secured at any eclipse was hardly dreamt of by the organisers of the expeditions. But when there has been this notable divergence between anticipation and actual result, the work done has proved of the greatest advantage to science. I shall not be sorry, therefore, if the following anticipations fail to include the most important advances made during the coming eclipse.

In the first place I think the records already obtained by large scale prismatic cameras have shown to everybody that these instruments are the most important ones we can employ on an eclipsed sun. They not only give us a complete chemical record, on a scale hitherto undreamt of, but they give us the positions and forms of the prominences far better than they have ever been obtained before. Nor is this all, they enable us to study under new conditions some of the conclusions arrived at in previous eclipses, and give us a means of inquiring into the possible origins of some of the phenomena already recorded by slit spectroscopes.

It is now more than a quarter of a century since bright lines were recorded in the spectrum of the dark moon. There could, of course, never have been any doubt that this was due to chromospheric glare in our atmosphere; but the moment this was conceded, the more difficult it became to determine the exact height of the solar envelopes, for if there was glare over the dark moon, how high might it not extend over the prominences?

Now one of the important points about the prismatic camera is that it is quite impossible for it to treat such a general glare as this in the same way it does any local illumination; as a result of this property any effect due to general glare which *can* be recorded by a slit spectroscope *cannot* be recorded by the prismatic camera, and so, roughly speaking, a comparison of the two records may be safely trusted to eliminate the effects of such glare.

It will be generally recognised that this is an important service to render; but there is another which, from the chemical point of view, is more important still—it enables us to localise the origins of the various radiations which build up the spectrum of the sun's surroundings, whether they be high or low.

For the first time in 1893 the corona was photographed as a ring by means of the prismatic camera in "1474" light, and apparently associated with it were other rings in the ultra-violet. The 1474 ring was best shown in the Brazilian photographs taken by Mr. Shackleton, but the others in the series taken by Mr. Fowler in West Africa. Now we find that the brightness of these coronal rings seems to depend upon proximity to the equator, and is entirely independent of the prominences. That the true spectrum of the corona will be eventually thus discerned is unquestioned, and the sooner it is done the better. This part of the attack this year has been greatly strengthened, and not only have we here prismatic cameras of 6 and 9 inches aperture, but I have equipped Mr. Shackleton with a powerful instrument for his observations in Novaya Zemlya, whither he has gone in the expedition rendered possible by the public spirit of Sir George Baden-Powell.

The large scale prismatic camera was, as I have said, introduced in 1893—that is, only three years ago. The results obtained in that year represent, therefore, only the experimental stage; at the critical moments of the eclipse—that is, at the beginning and end of totality—only snap-shots were taken. This time what is termed a dropping-plate is introduced in the programme of the 9-inch. That will be exposed, while gradually falling, from ten seconds before the end of totality to fifteen seconds after, in the hopes of catching the so-called "flash" which is supposed to represent the "reversing layer." To my mind, the reversing layer is dead and buried already, but may the fates be propitious on the 9th, and enable us to place a wreath on its tomb.

So much then, briefly, for the prismatic cameras and the pre-eminent importance of their use. I next come to another point, to investigate which an important instrument has already been set up.

In organising the work for the eclipse of 1871, stress was laid on the importance of obtaining a photograph of *all* the light radiated earthwards during an eclipse, to supplement the work of the slit spectroscopes which had to do with the light radiated by *special parts* of the solar surroundings.

This work is a thousand times more important now that the spectrum of the prominences is so clearly separated from that of the corona by the prismatic cameras, because it enables us to make a flank attack, so to speak, on the corona spectrum.

The integrating spectroscope to be used on the 9th consists of a 4-inch Taylor lens of long focus as collimator directed to the sun's place during totality in a way I will state further on; then come two prisms of 60° of dense flint, and lastly a camera of 19 inches focus. The light reflected from a dark cloud gives an exquisitely sharp and well-dispersed solar spectrum in 40 seconds. During totality a plate will be exposed for 60 seconds.

Now in this instrument, simply pointed to the sun's place, the light from the greatest area will give the brightest lines. We may therefore expect the coronal lines to be well visible; and since the prismatic cameras are certain to give us a complete record of the chromosphere and prominence spectrum, a simple subtraction will bring us face to face with the spectrum of the upper reaches of the solar atmosphere.

I next come to another matter, on which it is necessary to lay great stress. It is well known that Prof. Newcomb, in 1878, introduced into eclipse work the use of a disc, behind which the brighter lower layers of the sun's atmosphere, apparently surrounding the dark moon, were hid during the totality. The object of this is, of course, to shield the eye, and an additional precaution is to blindfold the observer till totality has well commenced.

Armed in this way, Prof. Newcomb was enabled to see long luminous extensions equalling in length several diameters of the dark moon along the sun's equator. Now since such long streamers had never been seen before, it has been imagined that they indicate a special form of corona visible at the period of minimum sunspot activity, for it was at very nearly this period that the eclipse of 1878 occurred.

But it may well be that the appearance may be due to the method employed, and that such an equatorial extension may be always there if only we can see it, and the greater the solar activity the more difficult is it to see it ordinarily, because this greater activity is always accompanied by a brighter lower corona.

Prof. Newcomb, I believe, used a disc of such a size that the brighter lower corona some 3′ above the dark moon was covered. I hope to repeat this observation, and to extend it by using several discs, one or more of which will cut off 5′.

Finally, I have a few words to say on the various features of the corona independently of the large extensions, which can best be specially dealt with by the disc observers.

Let us get photographic representations of this by all means; indeed amateurs are sure to provide them; but my own opinion is that a large telescope suited for obtaining such photographs would be much better employed with a prism in front of it.

I have no photographic telescope available, so I am forced to rely on drawings, which experience shows are better than photographs for feeble extensions. It is the fashion to ridicule these drawings, and I am free to confess that often there has been no resemblance between such drawings taken at the same place; still, all the eclipses I have seen have had coronas of very different forms; and further, the special features I recorded during the eclipse of 1878 were confirmed by the photographs.

On my way to Kiö, therefore, I determined to make an experiment, by the kind help of several of my shipmates on the Orient liner *Garonne*, to see how much the uncertainty of the result depended upon the absence of special training, and to what extent it could be eliminated.

FIG. 1.—The landing of the Exploring Party.

With this object in view, by means of a capital magic lantern which we had fortunately on board, I threw on the screen about a dozen photographs and drawings, coloured and otherwise, of various eclipses observed since 1869, describing the main points to be noted at the sun's poles, equator, &c. Finally, I threw a previously unseen corona on the screen, marking the time—I took 105 seconds—as during an eclipse.

It was amply proved that after a rehearsal or two such as this all the drawings were wonderfully similar.

This new bit of experience therefore showed that when made under good conditions such drawings become of the utmost value.

The enormous difference between the shape and brilliancy of the corona at the periods of maximum and minimum sun-spot activity was one of the revelations—the *unanticipated* revelations—of the eclipse of 1878. In that year the appearances of the corona in 1871, a year of sun-spot maximum, were fresh in my mind, and fortunately the eclipse of 1878 occurred at the period of minimum. The difference was marked in every way, and I said so. For a time the statement was disputed, nay, ridiculed, but I think everybody accepts it now. The conclusion was further intensified during the eclipse of 1886, which also took place near a minimum. In that year the eclipse happened in the morning, the observation place was Green Island in the West Indies in the middle of the rainy season, and the only thing I saw was first a cloud which formed and began to obscure the sun soon after the first contact, and grew till after totality; and next, some patches of sky away from the cloud-eclipsed eclipse. These patches swarmed with stars as on a darkish night; full moonlight was never suggested.

The sun now occupies a position in the constellation Leo, such that besides planets many stars of the first, second, third, and fourth magnitudes are conveniently situated for observation. It is obvious then that we have here, if it be properly utilised, a method of photometry easily applied, and I propose if possible to utilise it, since where doubt exists the more methods of observation we employ the better.

Such, then, are some of the points to which I attach the first order of importance. I next pass on to deal with the station selected for the observations.

The longer totality and higher sun in Japan seemed to make a station in that country most desirable, but a careful inquiry into the weather conditions showed the hopelessness of any attempt there. I was then driven to Norway, and although it was true that the totality here was short, it had to be borne in mind that a short totality in the case of a prismatic camera is really more advantageous than a long one, for the reason that the rings are more complete; the longer the totality the shorter the arc impressed on each photographic plate.

Since Dr. Common and many others had determined to observe on the north side of the Varanger Fjord, it seemed a duty to go to the south side, where the weather chances were bound to be about the same. In this case, however, a man-of-war was necessary as a base. This was a matter of utmost congratulation, for I knew how surely help could be depended upon, even in extending the area of observations.

Thanks to the intervention of the Royal Society, H.M.S. *Volage*, commanded by Captain King Hall, was ultimately detached for this duty, and my story will be very badly told if I fail to show what a debt of gratitude science owes to him and his ship's company for what they have done to secure such a record of an eclipse as has never been attempted before at a single station, and I may add that the gratitude will be none the less even if the eclipse is as efficiently clouded out as it was ten years ago.

On July 23 H.M.S. *Volage*, coming from Iceland with

most of the instruments on board, picked up at Hammerfest Mr. A. Fowler and Dr. W. J. Lockyer, who had been sent forward to erect and adjust them.

On the evening of the 24th the *Volage* arrived some seven miles south of Vadsö, and proceeded to land a party of explorers to find a suitable site for the encampment on the south side of the Varanger Fjord, which had been determined on, and also to make a survey of Bras Havn in order to find the most convenient anchorage.

After sending the party on shore, the *Volage* proceeded to Vadsö to communicate with the Governor (the Norwegian Government had already given permission to camp) as to the local weather conditions. The landing party, which consisted of Lieut. Martin and Sub.-Lieut. Beal, Mr. Fowler and Dr. W. Lockyer, and several bluejackets, together with Lord Graham, who had volunteered to help, proceeded to the shore in the steam cutter, having in tow the sailing cutter and the dingy, and provided with the necessary coal, water and provisions for two days. During the three-quarters of an hour steaming from the ship they encountered a sharp squall, which would have saturated everybody if it had not been for the invaluable sou'-westers and oilskins; and it is well here to note that if one goes to the north of Norway, these should always be found in the kit together with a pair of sea-boots.

The party landed, however, safely on a small island on the eastern shore of Bras Havn, and commenced immediately to put up tents. By eleven o'clock p.m., local time, all preparations were finished. The evening turned out so beautiful that a chat round the camp fire and a drop of grog were indulged in before turning in.

The first morning on this island was not by any means cheerful, rain was coming down in torrents, and the wind whistled round the tents in a most unwelcome manner. It was decided that the survey of the bay should be taken in hand first, so Lieut. Martin, Sub.-Lieut. Beal, and Lord Graham started off in the steam cutter and commenced operations. The weather did not improve, but rather the reverse; the survey, however, made good progress notwithstanding the unfavourable conditions, but all hope was given up of finding on that day a site for the observatory on the island near by.

Sunday morning was of a different type, and work was commenced at an early hour. Mr. Fowler and Dr. W. Lockyer were landed on Kiö Island while the survey was being finished. The island of Kiö lies nearly north of Bras Havn, at a distance of about a mile and a quarter. The island itself is small, and consists of gneiss moutonnéd and polished to a wonderful degree, the surface putting on the appearance of snow in many places. The rock is covered here and there with peat. At the first glance it seemed that a suitable site for the observatory was out of the question, but on examination a very fair spot was selected which appeared to improve the more acquaintance was made with it. To economise time the sites for the concrete pillars were settled upon, and pits were dug in the peat to sound for the solid rock.

With the evening came the *Volage* from Vadsö, and her arrival was gladly hailed by the whole surveying party, as provisions had run rather short, and peat water was not regarded as a luxury. The return of the ship meant that work could now be begun in earnest, so plans were laid for an early start on the morrow. Fortunately the day proved fine, and a good start was made at putting up the large 6-inch hut. This is the time when a warship at one's back makes everything easy. The gunner turned bricklayer for the occasion, and commenced, with the help of a couple of bluejackets, mixing and setting up concrete pillars for the 6-inch and siderostat. The ship's carpenters, with their assistants, went to work with zeal with the erection of huts. Others were employed in fetching from the beach sand and stones, which were required for the concrete pillars.

Levelling the camp occupied also the time of another half-a-dozen bluejackets. At the close of the day's work the appearance of the spot had entirely changed, and the Lapps who came and watched the work seemed to be very much astonished at the alterations taking place on their island. They were, however, very friendly, and seemed to be only too pleased to help in any way they could; their assistance, however, was not required, as sufficient was at hand.

FIG. 2.—The erection of the Huts.

The following day, which proved fine, saw even greater progress; for besides erecting the 6-inch prismatic camera and siderostat, a party of bluejackets was employed in carrying stones from the beach to place on the peat covering the floor of the camp. This was done in sailor fashion, and at the word of command "stone camp," the small path leading upwards to the camp was lined with bluejackets, and buckets, full and empty, were passing up and down respectively. The scene was an interesting one to watch, and, after two hours' work, a geologist might have found a genuine raised beach.

Bad weather, however, now set in, so work was restricted for the next two days mostly inside the huts. The integrating spectroscope was put together, photographic dark slides were blackleaded to run more easily in the grooves of the cameras, and two more tents were put up to protect the 9-inch prismatic camera and integrator from the weather. The latter was composed of ship's

materials, a sail being used for the covering; the tent served its purpose well, and withstood, like the others, a heavy blow from the east.

The two wet days were followed by two very fine ones, and great advance was made.

The foregoing account will give an idea of the kind of work done up to the end of August, the day of my arrival at Kiö. It was impossible for me to join the advanced party, so I subsequently proceeded direct to Kiö in the Orient liner *Garonne*. After a delightful voyage through the most wonderful of the Norwegian fjords under perfect travelling conditions, Captain Veale was good enough to slightly alter his course so as to drop me on the day named at a point about two miles north of the island, where I was met by the boats of H.M.S. *Volage*, which soon transferred the rest of the instruments and myself to the Eclipse camp.

It will have been gathered that when I arrived at Kiö, the services of other volunteers would be of any help to us. I replied that there was so much to be done that I thought I could usefully occupy all possible volunteers if the detail of duty on board left any time for instruction and training. I was at once taken at my word, and was requested to give, in lecture form, in the forecastle that evening a statement of what was required, and why it was useful to try to do it. This was done by the help of the magic lantern, which had been kindly lent me by the *Garonne*, the deck being darkened by sails laid over booms. After it was over the Captain called for volunteers. Many at once responded to the call, and, to make a long story short, I may say that at present the number of volunteers, including officers and men, is over 70.

The first thing to be done next morning with this wealth of help was to set to and compose a programme of eclipse work beyond all precedent.

Fig. 3.—The Volunteers.

all the fixed instruments brought out had been erected and adjusted as far as possible. I put in this qualification because, of course, all star observations were out of the question, as the sun at midnight was only 4° below the horizon.

Furthermore, profiting by the good will and keenness to assist on the part of the officers, full complements of assistants had been secured for the various manœuvres requisite to obtain the greatest amount of results in the restricted time covered by the totality.

But Captain King Hall was not satisfied with this contribution to our endeavours. He inquired whether

It was at once determined to form groups to sketch the corona, to note the stars visible during totality, to note the changes of colour of the landscape, discrimination being made between cloud, sky, and land and sea surfaces; to erect several discs cutting off the lower corona to different heights; and the swoop of the shadow of the moon was not neglected.

Further, as I had brought small polariscopes, prisms, and slit spectroscopes with me, other groups evidently had to be formed to use these instruments.

Two things then obviously had to be done at once—to select the artists and to start some spectroscopic demon-

strations among the more scientific-minded. Captain King Hall at once gave up his fore cabin for the one, and Staff-Surgeon Whelan lent spirit-lamps for the other.

The first competition among the volunteer artists took place at 9 p.m. on Tuesday, 4th, that is, the day before yesterday, and was repeated last night. There were about thirty-five entries. Ten marks were given for form, ten for colour. As on the *Garonne*, after a brief description, with photographs on the screen of the things to be looked for, and the lie of the sun's axis to the horizon of Kiö, a previously unseen coloured drawing of the eclipse of 1869, and a copy of Langley's drawing of that of 1878, were thrown on the screen, and the 105 seconds given out in proper eclipse fashion by means of a stop-watch. The similarity among the drawings on both occasions, and the accuracy of the notes on colours were truly marvellous; many full marks were accorded, and as a result sixteen of the volunteers were secured for the sketches of the corona, eight for the colours of the landscape, and four for observations of the moon's shadow. For the disc parties there were six volunteers, Captain King Hall himself taking charge of the first. For this work keen eyesight was, of course, of the first importance. The drill I had suggested for the officers of the Training Squadron is adhered to, the real observer being blindfolded till 10 seconds after the beginning of totality.

Of the Spectroscopic Classes little need be said; they include nine volunteers, and work has already begun.

The distribution of work among our party is now as follows:

Fixed Instruments.

1. 6-inch prismatic camera	5
2. 9-inch " "	6
3. Integrating spectroscope	4
4. Discs	6
5. 6-inch grating spectroscope...	6

Other Observations.

6. $3\frac{3}{4}$-inch telescope	2
7. Sketches of corona	16
8. Colours of landscape	8
9. Moon's shadow	4
10. Slit spectroscopes	4
11. Prisms for rings	2
12. Polariscope	2
13. Timekeepers	3
14. Contacts	4
15. Thermometers	6

Thus making a total of 78.

Fig. 4.—The Officers of H.M.S. *Volage*.

Three main stations were next fixed upon: Kiö, as headquarters; an island lying between Kiö and the *Volage*, on which a signal station has been erected to convey messages to and from the ship; and finally the top of the majestic cliff near which the ship was lying.

Before I pass from this part of the subject, it may be stated that the volunteers are from almost every rating. Besides the officers there are—I name them in the order in which they appear in the muster rolls of the various parties—petty officers, signalmen, marines, A.B.s, ordinary seamen, stokers, blacksmiths, shipwrights, engine-room artificers, and boys.

Very many inquiries were made at the various stopping-places in the north of Norway concerning the chances of fine weather in the neighbourhood of Vadsö. The English Consul at Hammerfest, where H.M. *Volage* picked up Mr. Fowler and Dr. W. Lockyer, informed them that the question of clear or foggy weather depended almost entirely on the direction of the wind. An east wind at Vadsö meant foggy weather, a west wind fine; the reverse was the case at Hammerfest. It was also mentioned that the south side of the Varanger Fjord seemed to be more free from fogs than the northern shore. The news seemed very encouraging, since it was proposed from the beginning to settle on the southern side. It was also made manifest that it would be unwise to select an elevated spot, since clouds and mists often were seen hanging about at 100 feet and over, while the lower levels rema ned clear. The experience, gathered from the first few days spent on the southern shore, did not, however, bear out very exactly the Hammerfest information. The 24th and 25th were both miserably wet days, and yet the wind was blowing hard the whole time from the north-west. The following two days were very fine and hot, the wind coming from the eastward. But the view as to the necessity of a low elevation has been quite justified by what has taken place here.

When mists were prevalent, Kiö has always been better off than the surrounding country. The hills to the south-east and south-west have often been wrapped in mists, while the eastern horizon at the camp has been as clear as a bell. So far we have only experienced one fog.

The weather so far has seemed to have a two-day period, two fine days following wet days. The 29th and 30th were wet and windy days, while the two following ones were moderately fine. On the s.s. *Garonne* I had an opportunity of consulting two pilots well acquainted with the Veranger fjord, and both informed me that the characteristic feature of the weather was that the mornings were fine and the sky was overcast later. This has so far in the main proved accurate. The eastward horizon (we have a sea horizon) has been nearly always clear in the earlier part of the morning, *i.e.* about six a.m., while towards six p.m. it was invariably cloudy. This gives us good encouragement, and make our chances of fine weather at the time of the eclipse very hopeful. And it may be stated, further, that the chances are that even if the eclipse morning proves misty, our place of observation will be the best available, and only clouds will prevent a successful issue.

J. Norman Lockyer.

(*To be continued.*)

NOTES.

Sir George Baden-Powell did science a very important service when he conveyed a small party of observers to Novaya Zemlya to record the characteristics of the eclipse of August 9. Mr. Norman Lockyer points out in the *Times* that, thanks to this timely aid, the failures in Norway and Japan are much less disastrous than they otherwise would have been. He has received a code telegram from Mr. Shackleton, one of his assistants who accompanied Sir G. Baden-Powell, stating that results just short of the best possible have been obtained. The programme of work arranged for Novaya Zemlya included a series of twenty-two photographs with the prismatic camera (that is, a long photographic camera with two large prisms of 60° in front of the lens). The exposures were to begin thirty seconds before totality, and were to end shortly after it. They varied from snap-shots to forty seconds. The times of exposures were arranged to secure specially the spectrum of the corona. Besides this work, to which the highest value is attached, three photographs of the corona were to be obtained with a long focus telescope of 4-inch aperture. It is a matter of congratulation that these instruments have been utilised, and as Dr. Stone, who also accompanied the party, was probably equally successful in making observations, we may say that the eclipse has been saved from entire failure, so far as British astronomers are concerned, by Sir G. Baden-Powell's assistance. As to Russian observers, a Reuter telegram from St. Petersburg, August 20, says:—"The Russian astronomical expedition, which was sent to the north of Finland to observe the solar eclipse, telegraphs from Tornea that, owing to the magnificent weather which prevailed at the time, ten good photographs of the corona were obtained by means of three different apparatus. The Hydrographical Department has received a telegram from General Baron Maidelicheff, of the Saghalien astronomical expedition. The message, which was despatched from Cape Notoro, the south-western extremity of Saghalien, states that the observation of the eclipse was fairly successful, and that, although the sky was cloudy, two photographs of the corona were obtained. Some magnetic variations were noticed during the eclipse."

At the moment of going to press, the following details have been received from Mr. Shackleton, with reference to his observations at Novaya Zemlya:—"I obtained about eight photos during totality. The most successful are those at the beginning of the eclipse, also at the end and the long exposure near mid-totality. The two photos near the beginning of totality are very interesting: the one nearest the time of the beginning of totality shows, I think without doubt, as many bright lines as there are in the Fraunhofer spectrum with the same instrument, so in all probability we have succeeded in photographing the 'reversing layer.' The plate at the end of totality also shows a great many lines, but not as many as at the beginning; probably they are the same as those photographed by Mr. Fowler in the metallic prominences of 1893—certainly most of them are. The long exposure near mid-totality gives a good ring at 1474 K, and also one near K (3969 λ), and several other fainter ones. The spectra are not so extensive in ultra-violet lines as those of 1893, probably because of the cloudy state of the sky. The corona-photos have also come out very well." We propose to refer more fully to the Novaya Zemlya observations in an article in our next issue.

The Royal Society was represented at the funeral of Sir John Millais, on Thursday last, by Dr. Michael Foster and Sir Joseph Fayrer. Among other scientific bodies, which honoured art in the person of the late President, were the Society of Antiquaries, the Royal Astronomical Society, the Linnean, Chemical, and Geological Societies, the British Museum, the Royal Geographical Society, the Institution of Civil Engineers, the Colleges of Physicians and Surgeons, and the Royal Institution of British Architects.

The success of Sir Martin Conway's expedition to Spitzbergen was noted in our issue of August 6. A Reuter's telegram from Tromsö, dated August 21, states that the whole party had arrived there on their way home. Mr. Garwood and Mr. Trevor-Battye had left the main party in Spitzbergen in order to explore Horn Sund, and they succeeded in reaching and ascending Hornsund Tind, a "marble mountain" in the middle of Southern Spitzbergen, which has hitherto only been seen from the sea. They studied the geology and glacier systems of the surrounding country, and encountered serious difficulties on account of the boisterous weather. By no means the least daring part of their journey was the return from Spitzbergen to Norway in a small steam launch of less than twelve tons, necessarily a much less seaworthy craft than a sailing boat of the same size.

A Reuter telegram states that the Danish cruiser *Ingolf* returned to Copenhagen on Thursday last from a long voyage,

under the leadership of Commodore Wandel, undertaken for the purpose of exploring the navigable waters round Iceland. The expedition, which lasted two years, was highly successful. In the southern part of Davis Strait the explorers discovered a submarine mountain range. The scientific results, especially from a hydrographical and zoological point of view, are said to be exceedingly valuable.

WE regret to announce that Prof. A. H. Green, F.R.S., Professor of Geology in the University of Oxford, died on Wednesday, August 19, at the age of sixty-four. We also notice with regret the death of Dr. Rüdinger, Professor of Anatomy at Munich Observatory; Mr. Frederick Brodie, whose name will be remembered by many astronomers in connection with drawings of Donati's comet of 1858; and Miss G. E. Ormerod, the sister of the well-known entomologist. Miss Ormerod took an active share in her sister's useful work.

HARVARD UNIVERSITY, and geology, have lost a distinguished worker by the death of Prof. Josiah Dwight Whitney. From a notice in the *Times*, we gather that Prof. Whitney was born at Northampton, Massachusetts, on November 23, 1819. He graduated at Yale in 1839, and in the following year he joined the survey of New Hampshire as assistant geologist under Mr. C. T. Jackson. Two years later he went to Europe, and pursued his studies in chemistry, geology, and mineralogy. On his return to America in 1847 he investigated the geology of the Lake Superior region, being appointed with Mr. J. W. Foster to assist in making a geological survey of the district. In 1855 he was appointed State chemist and professor in the Iowa University, and was associated with Mr. James Hall in the geological survey of that State, of which he published an account. From 1858 to 1860 Prof. Whitney was engaged on a geological survey of the lead region of the Upper Missouri in connection with the official surveys of Wisconsin and Illinois. He was appointed State geologist of California in 1860, and conducted a topographical, geological, and natural history survey of that State till 1874, when the State Legislature discontinued the work. Besides numerous pamphlets and annual reports, Prof. Whitney issued "Geological Survey of California" (six vols., Cambridge, 1864–70). In 1865 he was appointed Professor of Geology at Harvard University, and retained the chair till his death. The honorary degree of LL.D. was conferred on him by Yale in 1870. Prof. Whitney was one of the original members of the National Academy of Sciences named by Act of Congress in 1863, but he subsequently withdrew from that body. He was a member of a large number of scientific bodies, both at home and abroad. He translated Berzelius's "Use of the Blowpipe" (Boston, 1845), and he wrote a guide-book to the Yosemite (San Francisco, 1869). It is a significant testimony to his scientific eminence that Mount Whitney, the highest mountain in the United States, is named after him.

AN International Exhibition of Gardening will be opened at Hamburg at the beginning of May next, and close at the end of September. The Exhibition is intended to comprise all branches of gardening and the cultivation of all kinds of plants.

THE fourth International Congress of Criminal Anthropology was opened at Geneva on Monday, and is to last till Saturday. Great Britain is officially represented, and Mr. Francis Galton, F.R.S., is among those who are down to read papers at the Congress.

THE Paris correspondent of the *Chemist and Druggist* states that the crypt made under the principal entrance of the Rue Dutot Institute, which is to contain Pasteur's tomb, is rapidly approaching completion. At the entrance of the vault is the following inscription in French:—"Happy is he who carries within himself a God, an ideal of Beauty, and obeys it; an ideal of Science, an ideal of the virtues of the Gospel." In the interior the arches are decorated with groups of animals, surrounded by frameworks of vines, mulberries and hops. Symbolical winged figures, representing Faith, Hope, Charity, and Science, appear in the centre of the cupola, forming a highly artistic group, and one which is identified with the illustrious savant's character. It is probable that the remains of the great chemist will be transferred to the Institute from Notre Dame on December 27, the anniversary of his birth.

THE International Exhibition to be held in Brussels next year promises to be of a very important character. Though commenced as a private enterprise, it is now a national undertaking, assisted by the State, and having as its patron King Leopold, while the Count of Flanders has accepted the honorary presidency. The French Government has made a grant of £35,000; Germany has so far voted no money, but has formed a powerful commission, under the presidency of Prince Charles of Hohenzollern; the United States has made a grant; the South American Republics will, in nearly all cases, be represented, and it is expected that there will be Italian, Russian, Austrian, and Scandinavian Courts. As for this country, the Government is taking an interest in the success of the undertaking, and at its request a British Commission has been formed under the presidency of Sir Albert Rollit, and with Mr. James Dredge, one of the editors of *Engineering*, as executive commissioner. It is hoped that British science, art, and industry will be worthily represented at the Exhibition.

WITH reference to the period of extremely hot weather in the United States, a correspondent writes:—"The hot weather began on August 4, and for eight days succeeding was felt over the greater part of the United States. The deaths on Tuesday, August 11, both in New York and in Brooklyn, surpassed all previous records, but were again exceeded on the following day. In the twenty-four hours ended at noon, August 13, 374 death certificates were filed at the Bureau of Vital Statistics in New York City. Of these the cause of death given in 158 cases was sunstroke. The total number of fatal sunstrokes in eight days was 617. Coroners and undertakers have been unable to dispose of the dead with sufficient speed to protect the health of the living. Lower animals, horses, dogs and cats, have died by thousands. Over one thousand horses perished in New York City, and facilities for removing the bodies were so inadequate that many remained for days where they fell. Some of the busy thoroughfares of the city were strewn with dead horses like a field of battle. In one instance, eighteen were said to be lying in one street within a short distance of each other. Brooklyn fared somewhat better on account of its proximity to the ocean; but Chicago was stricken almost like New York City. In many smaller cities similar effects were produced, and it will be impossible ever to make an accurate statement of the total fatality. In the Central Western States, the temperature rose to 110° and 115° in structures exposed to the sun at many points, and even 125° was reported from portions of Illinois, not, of course, in shaded observation stations, but in inhabited buildings."

THE seventh annual meeting of the Museums Association, held at the latter part of July in Glasgow, was a most successful one from every point of view, and in some of its importan features it exceeded any of the previous conferences. The whole of the arrangements for the meeting were carried out by the Corporation of Glasgow, who gave a very cordial welcome to the Association, and offered them every facility for inspecting the museum schemes, some developed and others developing, which mark Glasgow out as probably one of the most advanced in the kingdom in its recognition of the important value of museums and art galleries to the people of a great community. In Kelvingrove Park the Corporation are erecting a science

and art museum of palatial dimensions at a cost of over a quarter of a million, and while thus recognising the need of a central building, adequate to the exposition of science and art in its broadest sense, they have endeavoured to meet the natural requirements of an extensive city by establishing subsidiary museums in various parks and open spaces, the latest of these being the Camphill Gallery in Queen's Park, devoted at present to special exhibitions. In his presidential address Mr. James Paton, Curator of the Galleries and Museums, gave an interesting account of their foundation and progress. The papers read at the meeting included such practical subjects as descriptive labels for geological collections, by H. Bolton. electrotypes in Natural History Museums, by F. A. Bather; Type specimens in Botanical Museums, by E. M. Holmes; Chemistry in Museums, by George W. Ord; illustrated lectures in Museums, by Thomas Rennie; the lighting of Museums, by Thomas White; and a paper by F. A. Bather, on how may Museums best retard the advance of science, in which in a satirical vein he pointed out how the storage or even exhibition of specimens is not necessarily conducive to the elucidation of their history and structure. In addition to the various Glasgow museums, the members of the Association paid a visit to Perth, on the invitation of the Lord Provost, and they there had the opportunity of inspecting, under the able guidance of Mr. Henry Coates and Mr. Alexander M. Rodger, one of the most recent, as it is the most interesting and attractive, museums of a purely local character that has ever been formed in Britain.

THE interest of Prof. Ewart's experimental stud at Penicuik, Midlothian, was increased, a few days ago, by the arrival of a hybrid between a male Burchell's zebra (*Equus burchelli*) and a mare (*Equus cabattus*). Though the mare is jet black, the foal, except over the hind-quarters, has as many bands as its zebra parent. The bands are fawn-coloured, the background nearly black. But though the hybrid by its stripes suggests the zebra, in form it closely resembles an extremely well-bred foal. Should the mare have a foal to Prof. Ewart's Arab horse "Benazrek," provided with stripes and other zebra-like features, an important step will have been made in justifying breeders in believing in Telegony, or, as it is familiarly called, "the infection of the germ." When the present hybrid colt and the hybrids expected next summer reach maturity, it will be alike interesting and important to ascertain whether they are fertile with each other, and with pure horses, zebras, and asses.

IN a very interesting paper on the geology of Novaya Zemlya (*Izvestia* of the Russian Geographical Society, 1896, i.), Prof. Chernysheff points out the difference which exists between the middle parts of the island and its southern part. The latter, which must be considered as a continuation of the Pai-kho, or northern Ural ridge, is a plateau consisting of Lower Permian deposits (Artinsk layers) stretching north-west; while in the north of Bezymyannaya Bay (72° 40′) the island consists of an Alpine region, rising to an altitude of 4000 feet, and is built up of Devonian rocks, stretching north-east, and intersected by deep transversal valleys of aqueous origin, such as Matochkin Shar, and several others. It may be added to this fundamental fact, fully established by M. Chernysheff, that we should thus find in Novaya Zemlya a repetition of what is seen further south in the Urals, which also consist of plateaus stretching north-west, and of chains of mountains having a north-eastern direction. The whole of the island has been extensively glaciated. Immense moraines have been accumulated at levels which are much higher than those on which we now find *firn*-fields in the south, and in the north big moraines are found, where there are no glaciers at the present time, or only very small ones. The glaciation of Novaya Zemlya was contemporaneous with the glaciation of North Russia, and was followed by a period of subsidence, during which an archipelago of small islands was all that remained of the big island. Terraces of marine origin, containing shells of molluscs now living in the Arctic Ocean, are admirably well developed along the shores, up to an altitude of 160 metres above the sea-level. At the present time the island is in a period of upheaval, and its glaciers are again on the increase. Large fields of *firn*, in which the ice has the same structure as in glaciers, are spread over the southern plateau; while further north, in the Alpine tracts, young glaciers are being formed; so that if the same conditions continue to prevail, the island will become again the ice wilderness it formerly was.

PROF. A W. RÜCKER contributes to the July number of *Terrestrial Magnetism* a summary of the results of the recent magnetic survey of Great Britain and Ireland, conducted by Dr. Thorpe and himself. Prof. Rücker presents his valuable summary under three heads. (1) On the accuracy of the delineation of the terrestrial isomagnetic lines. (2) On the accuracy of the determination of the local disturbing magnetic forces. (3) On the relation between the magnetic and the geological constitution of Great Britain and Ireland. Illustrations accompany the article. An investigation of magnetic disturbances during the interval 1890-95, as taken from the records of the Potsdam magnetograph, is described by G. Lüdeling. For this interval the author fails to find a marked relationship between the annual curve of sun-spot frequency and the annual variation of magnetic disturbances. There is, however, a close correspondence in the diurnal and in the annual variation of the disturbances and of polar lights as observed at Oxford.

THE mode by which light and Röntgen rays are able to bring about the discharge of an electrified surface, is discussed by Dr. Oliver Lodge in *Science Progress*. Experiments were carried out by him with the object of testing the presence of metallic particles or vapour near an electrified metal rapidly discharging under the action of light. The results lead to the conclusion "that the discharge of electricity from illuminated surfaces is not effected by evaporation of those surfaces, but that the molecules, which convey the charge, belong to something in the gas, and not to the illuminated body." It is suggested that the discharge of an electrified surface by Röntgen rays—an action which seems to be brought about by the conversion of the gas, or other insulating material, near the charged body into a conductor—is probably effected "by dissociating the substances into charged atoms which are then free to act as carriers, and speedily convey to a distance the charge of an electrified body by journeys along the lines of force. It may be that ultra-violet light acts in somewhat the same way, but not in exactly the same way." As to the nature of the rays, everything now indicates them to be transverse vibrations, and Dr. Lodge thinks their wave-lengths are not much greater than the size of atoms.

PROF. VICENTINI, whose microseismograph has been noticed several times in these columns, has recently erected at Padua an important modification of his instrument. His original microseismograph at Siena consists of a pendulum whose bob remains nearly steady during rapid vibrations, and the movements of the ground are magnified, first by a vertical lever, and still further by two horizontal levers at right angles to one another. In this form, it is most useful for giving the times of the different phases of a disturbance; but, owing to the comparatively small velocity (2 mm. per minute) of the paper on which the movements are recorded, it furnishes but little information as to the direction of the displacements. At the suggestion of Dr. Pacher, the pair of horizontal levers has been replaced by a small and very light pantagraph; the weight of the bob has also been increased from 50 to 100 kg., the length of the pendulum from 1·50 to

3·36 metres, and the velocity of the paper to about 15 mm. per minute. The diagrams are of course distorted in the direction in which the paper moves, and they no longer give the exact times of particular phases; but, acting in concert with the older form, the new microseismograph furnishes valuable data with regard to the character and direction of the pulsations. In the paper by Prof. Vicentini and Dr. Pacher, in which these changes are described (*Atti del R. Ist. Veneto di scienze*, &c., vii., 1896), two interesting diagrams are reproduced, both corresponding to very distant, but unknown, earthquakes—one on December 25, 1895, and the other on January 15, 1896.

WE have received from Dr. Joachim Sperber, of Zurich, a *brochure* of 37 pp. on the parallelogram of forces regarded as the basis of the periodic system in chemistry. After applying the principle to a number of numerical calculations, the author remarks in conclusion, that the stereochemistry of carbon and nitrogen is nothing but a case of resolution into components in different directions. The paper is published by E. Speidel, of Zurich.

AMONG the 300 species, or thereabouts, of plants which Lundström and others describe with more or less accuracy as acarophilous, no gymnosperms or monocotyledons have hitherto been included, but Dr. de Gasparis, in the *Rendiconto della R. Accad. delle Scienze fisiche e matematiche* (Naples), describes a monocotyledon *Scindapsus dilaceratus* as having *Acarus*-galls produced freely at the bases of the leaf-segments. He describes them as being produced undoubtedly as the result of puncture, and details the changes which take place in the mesophyll of the leaf, resulting in a small chamber surrounded by many layers of special cells. Although he apparently accepts Lundström's view that these *Acarus*-galls are a strict case of symbiosis, the plant profiting alike by the secretions of the *Acari*, and by the latter consuming fungus spores, &c., which otherwise might germinate upon the epidermis of the plant, he produces no evidence to show that in this particular case symbiosis exists

WE have received from the agricultural department of the Glasgow and West of Scotland Technical College a *brochure* of seventy pages, embracing reports on experiments on the manuring of oats, hay, and turnips, on finger-and-toe in turnips, and on the spraying of potatoes, conducted in 1895 by Prof. R. P. Wright and others on farms in the south-west and centre of Scotland. The results of the experiments upon the oat-crop indicate that nitrogenous manures, such as nitrate of soda and sulphate of ammonia, applied alone, retard ripening, but give large and profitable, though somewhat irregular, increases of crop; also that these nitrogenous fertilisers are more uniform and more regular in their action when applied with a soluble phosphatic manure, particularly superphosphate of lime. In the case of the fungoid disease finger-and-toe—known also as club-root or anbury—confirmation is afforded of the previously ascertained fact that liming, if done early, will benefit a crop of turnips on land where the disease is prevalent. The spreading out on lea land of diseased roots to be consumed by stock is very properly condemned. It may be mentioned that finger-and-toe is very prevalent this season, especially in Scotland and the North of England, and it is no doubt a source of serious loss; the pathogenic organism is *Plasmodiophora brassicæ*. It is difficult to understand why the spraying of the potato crop with *bouillie bordelaise*, as a check upon the potato disease, should give such indifferent results in Scotland, whilst the practice has been attended by substantial benefit in England and France, and particularly in Ireland. We quite agree that, at present, "it would be rash to draw definite conclusions" from the general results of the experiments that have hitherto been made in Scotland.

MESSRS. G. BELL AND SONS have sent us an advance prospectus of a work they are about to publish under the title "Men and Women of the Century." The work comprises a series of portraits of notable men and women who have sat to Mr. Rudolf Lehmann between the years 1847 and 1895, each portrait signed with the autograph of the sitter. There will be twelve photogravures, from paintings, and about seventy facsimile reproductions of the drawings in half-tone, some of them printed in colours, and all executed by the Swan Electric Engraving Company. Among the scientific men whose biographies and portraits are given are the following:—A. von Humboldt, Louis Pasteur, Sir Richard Owen, Prof. Virchow, Prof. Huxley, Prof. Burdon Sanderson, Prof. Mommsen, Prof. Max Müller, Prof. Du Bois Reymond, Sir William Siemens, von Ranke, Sir David Brewster, Sir Henry Bessemer, and Sir Spencer Wells. The collection will thus form an interesting private gallery of contemporary portraits. It is edited by Mr. H. C. Marillier, who contributes an introduction and the short biographical notices.

THE additions to the Zoological Society's Gardens during the past week include a Capybara (*Hydrochœrus capybara*) from South America, presented by Mr. F. W. Temperley; a —— Fox (*Canis* ——) from Nicaragua, presented by Mr. F. A. Pellas; a Black-necked Grackle (*Gracupica nigricollis*) from China, presented by Dr. Nowell; a Salt-water Terrapin (*Clemmys terrapin*) from Florida, presented by Miss Hole; two Brush Turkeys (*Talegalla lathami*) from Australia, deposited; a Yak (*Poëphagus grunniens*, ♂); an English Wild Cow (*Bos taurus* var.), a Wapiti Deer (*Cervus canadensis*, ♀), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL CONSTANTS.—Some account of the completed work of Drs. Gill and Elkin on the determination of astronomical constants by means of heliometrical measurement is given in the *Bulletin Astronomique* for August. The values there given differ by minute amounts from those contained in the preliminary paper published in the *Monthly Notices* for April 1894. For Solar Parallax the following values have been derived:—

From observations of Victoria	...	8″·8013	... ±0″·0061
,, ,, Sappho	...	8·7981	... ±0·0114
,, ,, Iris	...	8·8120	... ±0·0090
Mean value	...	8·8036	... ±0·0046

The value given by the Iris measures is slightly greater than that from the other asteroids, and the suggestion is made, but not insisted upon, that this might be explained by the light of Iris being somewhat less refrangible than that of the stars with which it has been compared, a fact that Dr. Elkin has noted in the course of his observations. Prof. Newcomb has pointed out that a not impossible difference between the spectrum of the planet and star could affect the resulting parallax to the extent of two or three hundredths of a second. Since, however, the mean value of the parallax does not differ from that derived from the observations of Iris by more than the probable error, no definite conclusion can be drawn on this point.

The value of the moon's mass, derived from the discussion of the observations of Victoria is

$$\frac{1}{81 \cdot 702 \pm 0 \cdot 094} = 0 \cdot 012240 \pm 0 \cdot 000015.$$

This result is believed to be free from the effects of any systematic errors.

The Constant of Nutation is given as 9·2068″±0·0034″, a value that lies midway between the generally accepted values of Newcomb and Chandler, viz. 9·210″ and 9·202″ respectively. This satisfactory agreement again points to the successful elimination of all systematic errors.

SMALL PLANET OBSERVATIONS.—The asteroid Abundantia, No. 151, has offered for solution a very curious problem. Since its discovery in 1875, it has been observed, or at least

observations purporting to refer to that planet have been made, at seven oppositions. When these are submitted to rigorous treatment and the perturbations carefully computed, it is found that the observations in 1875, 1879, 1886, and 1887 can be represented with satisfactory accuracy, but the observations of 1881, 1885, and 1894 cannot be satisfied with the same elements. While the normal places formed from the first-mentioned four years have only nominal errors, those in the other years present the following deviations :—

1881	...	$d\alpha = + 25^s.29$	...	$d\delta = - 2' \; 19''.1$
1885	...	,, $= + 38^s.20$	...	,, $= - 2' \; 0''.8$
1894	...	,, $= + 30^s.48$	...	,, $= - 3' \; 55''.3$

The obvious explanation that some numerical error in the calculations has led to this unusual result is excluded by the detail that Lieut.-Col. von Groeben has given in his description of the processes employed (*Ast. Nach.*, No. 3372). To suggest that another small planet exists moving in a similar orbit, and at present in a very similar position in that orbit, is likely to meet with opposition. The difficulty remains, however, unexplained. The similarity of the deviations from the computed path of Abundantia, both in amount and in direction, is a suspicious circumstance which, however, does not offer a definite clue. Future observation must be looked to for the explanation of the enigma, and von Groeben furnishes an ephemeris for 1896 November, which may induce observation and supply the solution of the riddle. Photographs of the district seem to offer the most likely solution, since the existence of the hypothetical planet, probably of equal brilliancy with Abundantia, should declare itself on the photographic film at no greater distance from the real or known planet than is shown by the errors above.

CYCLES OF SOLAR ECLIPSES.—In the *Bulletin de la Soc. Ast. de France* for July 1896, p. 248, M. C. Flammarion gives the history of the recent eclipse as an example of the well-known period of 18 years 11 days, the Saros, and in the course of the paper several new points are elucidated. Thus in considering any set of solar eclipses, the constants of each are found to vary regularly according to the position in the cycle. Taking the place on the central line where an eclipse begins, the next eclipse in the cycle, after an interval of 18 years 11⅓ days, will begin at a place about 118° west longitude, while another similar period will cause the third eclipse to begin in very nearly the same longitude as the first one. When plotted on a globe, the traces of the consecutive shadows appear curiously regular in the form of a triangle round the pole.

In latitude each eclipse begins a little *north* of its predecessor; the difference is about 8° for the beginning of eclipse, 4° for the middle, and 2° for the end. Continuing, it is found that the fourth eclipse has a path almost parallel to the first, but much to the north. It thus appears that in a given region a solar eclipse will recur after an interval of three ordinary cycles, each of 18 years 11½ days.

This secondary period of fifty-four years comprising three metonic cycles, M. Flammarion thinks has been unnoticed, and the remarks that it may prove more useful than the smaller period, or Saros, in predicting solar eclipses. There appears to be a regular march of the line of totality from the south to the north pole, the time taken being ten of the long cycles, or about 540 years.

STARS HAVING PECULIAR SPECTRA.—Prof. E. C. Pickering, in *Ast. Nach.*, 3370, gives details concerning the spectra and positions of eighteen stars which have been found by Mrs. Fleming to possess peculiar spectra, giving suspicion of variability. Seven of these are set down as being of Type IV., but three only are of the normal type, the remaining four containing lines of shorter wave-length.. New evidence has been obtained regarding two objects previously announced as having peculiar spectra, in *Ast. Nach.*, vol. cxxxv. p. 195, and they are now shown to belong to a different type to that formerly given. One of these, whose position for 1900 is R.A. = 17h. 38·2s., Decl. = − 46° 3′, was thought to be a stellar object having the spectrum of a gaseous nebula, but now proves to have a faint continuous spectrum, together with *bright* hydrogen lines, H_β, H_γ, H_δ, H_ϵ, H_ζ. The bright nebular line at 5007 is absent, so that this body more nearly resembles η Carinæ. The second object has the position R.A. = 18h. 39·3m., Decl. = − 33° 27′; formerly announced as being of Type V., it now proves to have the spectrum of a gaseous nebula.

COMET BROOKS (1889 V.), 1896.—The accuracy of the revised ephemeris of J. Bauschinger, noted in NATURE, August 13, has been confirmed by an observation of the comet made by H. Kobold, at Strasburg Observatory, on August 11 (*Ast. Nach.*, 3372, p. 206). He describes the comet as being feeble, and about 0·5′ of arc in diameter; in form round, with a small central condensation. The observation is considered fairly trustworthy. As the corrections the observer gives for reducing the positions stated in the ephemeris to those actually observed are only −0·49s. and −0·7″ in R.A. and Decl. respectively, the ephemeris will need no alteration for purposes of continued search.

CONTRIBUTIONS TO THE ANTHROPOLOGY OF BRITISH INDIA.

MR. EDGAR THURSTON, the energetic Superintendent of the Madras Government Museum, has recently turned his attention from zoology to anthropology, and in his fourth *Bulletin* has published the first of what we hope will be a series of investigations on the ethnography of the Madras Presidency. Thanks to the example set by Mr. Risley, the reproach of lack of interest in the natives of India on the part of residents is now being removed, and we hope that Mr. Thurston and others will continue this extremely important line of study. The title of the memoir is "Anthropology of the Todas and Kotas of the Nilgiri Hills; and of the Brahmans, Kammalans, Pallis, and Pariahs of Madras City." A large number of measurements are published, and the paper is illustrated with twenty-one plates, many of which are excellent.

One-half of the *Bulletin* deals with that very interesting autochthonous people, the Todas, who are nearly as hairy as the Ainu, and who likewise exhibit affinities with the Australians, although their high, straight nose, and fairly regular features, give them a more pleasing appearance than the latter. The typical Toda man is above medium height (5 ft. 6¾ in.), well-proportioned, and stalwart; he is dolichocephalic (73·3), with projecting superciliary ridges. A valuable account is given of the customs and religion of these herdsmen, which supplements previously published descriptions. Morality is reduced to a very low ebb before marriage, and truthfulness is not held in great regard. The Todas are endogamous as a tribe, and even as regards some of the five clans, intermarriage between the Paiki and Pekkan clans is said to be forbidden. The buffalo sacrifice is their only purely religious ceremony; it is supposed to bring good luck, and make the buffaloes yield abundant milk. A buffalo calf is killed by a blow on the head from a piece of sacred wood; the assembled Toda men (women are not permitted to take part in the ceremony) salute the dead animal by placing their foreheads on its head. According to Breeks, the flesh must be roasted on a fire made by rubbing two sticks together, and eaten by the celebrants. That is, the divine animal is periodically killed without shedding its blood, the flesh is not sodden by boiling, and the communicants eat their divinity for the benefit of the community: save on these occasions the Todas never eat meat. Mr. Thurston, however, was informed that the flesh is given to the Kotas.

The Kotas, who are allied to the Todas, are excellent artisans, being especially skilled as blacksmiths—they also pursue agriculture; but they are universally looked down on as being unclean feeders and carrion-eaters. Their diet evidently agrees with them, as they are a hard, sturdy set of men. Several of their customs are detailed. The Todas are slightly taller (1696 mm.) than the Kotas (1629 mm.), but they have the same weight (115 lbs.). They are also broader shouldered, and, though they do less manual work, their hand-grip is considerably greater. The cephalic measurements in both average about the same (length, 19·2 mm.; breadth, 14·2 mm.; index, 74).

The short account of the measurements of forty men of each of the four Bengal castes is suggestive. It is evident that the Brahmans are here a mixed Aryan and Dravidian people; below these are the Kammalans, or artisans; still lower are the Pallis, or agriculturists; and the lowest are the Pariahs; but there are traces that these once held a higher position. Risley found the nasal index coincided to a remarkable extent with the caste rank. And here we find the same story; for these four castes it is, respectively, 76·7, 77·3, 77·9, and 80; but the Pariahs are eclipsed by the Paniyans (95·1), about whom Mr. Thurston promises us further information. There is very little difference in height between the Brahmans (1625 mm.) and the Pariahs

(1621 mm.), but the Kammalans are shorter (1597 mm.). The Brahmans are better nourished, and have broader heads (142 mm.), the other three castes averaging 137 mm.; they also have the largest hands. Taking them all round, there is not that difference between the Brahmans and Pariahs that one might expect to find; but this can be explained by racial mixture. A. C. H.

SCIENTIFIC EDUCATION IN GERMANY AND ENGLAND.[1]

IN our frequent discussions on scientific education, we have both often been struck with some points of very great difference between the English and the German way of dealing with it. As it may be asserted without national arrogance that University education is in Germany in a more satisfactory condition than in your country, you are, of course, anxious to know which of the German customs I consider most effective in bringing about this better state of things; and I will, therefore, try to point them out. Of course, I shall confine myself to the subject of natural science, and especially chemistry and physics, feeling myself unable to deal with sciences beyond my knowledge. The main point of our system may be expressed in one word—freedom—freedom of teaching and freedom of learning. The first involves for the teacher the necessity of forming in his mind a clear conception of the scope of his science, for, as he is free to choose any possible method of view, he feels himself answerable for the particular one he has chosen. And in the same way the student feels himself responsible for the method and the subjects of his studies, inasmuch as he is free to choose any teacher and any subject. One who has not seen this system in action may be inclined to think that such a system must lead to arbitrary and irresponsible methods on the side of the teacher, and to confusion on the part of the student. But the former is avoided, because at the beginning of his career the teacher is dependent for his advancement on the results of his scientific views, and is naturally anxious to improve his position in the educational world. And as for the students, they themselves impose certain restrictions on their own freedom. Most of them feel that they require some advice and guidance, and they therefore follow the usual and approved order in conducting their studies. As to the inventive man of original ideas, it has often been proved that for him any way is almost as good as any other, for he is sure to do his best anywhere. Moreover, such a man very soon excites the interest of one of his teachers, and is personally led by him, generally to the great advantage of both.

Let me illustrate these general remarks by considering the course followed by an average chemist. In his first half-year he hears lectures on inorganic chemistry, physics, mineralogy, sometimes botany, and of late often differential calculus. Moreover, the German student is accustomed to take a more or less strong interest in general philosophy or history, and to add in his *Belegbuch* (list of lectures) to the above-named *Fachcollegien* (specialised studies) one or two lectures on philosophy, general or German history, or the like. Very often there are in the University one or more popular professors whose lectures are heard by students of all faculties without reference to their special studies. The student who has heard during his stay at the University only lectures belonging strictly to his *Fach*, is not well thought of, and is to some extent looked down on as a narrow specialist. But I must add that such views are not prevalent in all faculties, and there are some—*e.g.*, the faculty of law—whose students confine themselves, with few exceptions, to attending exclusively lectures in that faculty.

In the second half-year the chemical student begins with practical laboratory work. Notwithstanding the perfect freedom of the teachers, the system first introduced by Liebig into his laboratory at Giessen is still universally adopted in German universities and technical high schools—viz. qualitative and quantitative chemical analysis, the former conjoined with simple spectroscopic work, the latter amplified by volumetric analysis. This is followed by a course of chemical preparations, formerly chiefly inorganic, now chiefly organic. Even here, a regular system is being widely developed owing to the use of some well-known text-books. Of late years this course is followed in some laboratories by a series of exercises in physical chemistry and electro-chemistry.

While these practical exercises, which last for three or four half-years, are being carried out, the student completes his knowledge of physics, mathematics, and the other allied sciences by hearing lectures and working practically in the physical and often also in some other laboratory. The exercises done, he goes to the professor and asks him for a "theme" to begin his "work"—viz., his dissertation for the degree of Doctor of Philosophy. This is the most important moment in his life as a student, for it generally determines the special line of his future career. The "theme" is usually taken from the particular branch of the subject at which the professor himself is working; but, as the scientific name and position of the professor depends, not only on his own work, but to a large extent on the work issuing from his laboratory, he is careful not to limit himself to too narrow a range of his science.

Of course it is best of all if the student selects for himself a suitable "theme," suggested to him by his lectures or practical work, or from private study of the literature of the science. But this seldom happens, for the young student is not yet able to discern the bearing of special questions, and lacks knowledge how to work them out. Sometimes (but not very often, indeed) he points out to his professor in a general way the kind of problems he would like to work at, and the professor suggests to him a special problem out of this range of subjects. During the working out of his chosen subject the student learns generally much more than he has heard at lectures. Every part of the investigation forces him to revise the scientific foundations of the operations he performs. During this time the incidental short lectures given by the professor on his daily round from one to another of the advanced students are most effective in deepening and strengthening the student's knowledge. As these explanatory remarks are generally heard not only by the student whose work has caused them, but also by a number of fellow-students working near, a fairly wide range of scientific questions are dealt with in their hearing. Often these small lectures develop themselves into discussions, and, as for myself, I judge from the frequency of such discussions between the students whether the session will turn out a good one or not. If the professor thinks the work sufficiently complete to be used as a dissertation, the student proceeds to the close of his studies. He prepares himself for the examination, which is conducted by the very professors whose lectures he has heard and in whose laboratories he has worked. This examination varies somewhat in different universities, but in no case is it either very long or extensive; indeed, it is not considered as very important. For we are all aware what an uncertain means of determining a man's knowledge and capabilities an examination is, and how much its issue depends upon accidental circumstances. Part of this uncertainty is removed by the fact that the professor and the pupil know each other, are acquainted with one another's modes of expression and scientific views. The main purpose of the examination is to induce the student to widen his knowledge to a greater extent than is covered by the subject of his dissertation; but, indeed, it happens very seldom that a student whose work is considered sufficient does not pass the examination.

We have no great fear that this system may induce a professor to treat his own pupils in too lenient a way, and so lower the standard of the Doctor's degree. There was a time when such abuses used to occur, but there very soon arose such public indignation that the abuses ceased to occur. Even at the present day similar instances occasionally occur, but, as before remarked, the position of a professor depends in such a degree upon the value of the dissertations worked out under his supervision, that such deviations from the right way correct themselves in the course of time. The most effective instrument for that purpose is the publication of all dissertations and the consequent public control over them; for this reason publication is, I believe, compulsorily prescribed in all German universities.

When the student has finished his course he is still entirely free to choose between a scientific and a technical career. This is a very important point in our educational system; it is made possible by the circumstance that the occupation of a technical chemist in works is very often almost as scientific in its character as in a university laboratory. This is connected with a remarkable feature in the development of technical chemistry in Germany—the very point upon which the important position of chemical manufacture in this country depends. The organisation of the power of invention in manufactures and on a large

[1] A letter from Prof. W. Ostwald, communicated by Prof. W. Ramsay to the *Times*, August 25.

scale is, as far as I know, unique in the world's history, and it is the very marrow of our splendid development. Each large work has the greater part of its scientific staff—and there are often more than 100 *doctores phil.* in a single manufactory—occupied, not in the management of the manfacture, but in making inventions. The research laboratory in such a work is only different from one in a university by its being more splendidly and sumptuously fitted than the latter. I have heard from the business managers of such works that they have not unfrequently men who have worked for four years without practical success; but if they know them to possess ability they keep them notwithstanding, and in most cases with ultimate success sufficient to pay the expenses of the former resultless years.

It seems to me a point of the greatest importance that the conviction of the practical usefulness of a theoretical or purely scientific training is fully understood in Germany by the leaders of great manufactories. When, some years ago, I had occasion to preside at a meeting, consisting of about two-thirds practical men and one-third teachers, I was much surprised to observe the unhesitating belief of the former in the usefulness of entirely theoretical investigations. And I know a case where, quite recently, an "extraordinary" professor of a university has been offered a very large salary to induce him to enter a works, only for the purpose of undertaking researches regarding the practical use of some scientific methods which he had been working at with considerable success. No special instructions are given to him, for it is taken for granted that he himself will find the most promising methods; only, in order to increase his interest in the business, part of his remuneration has been made proportional to the commercial success of his future inventions. From this clear understanding of the commercial importance of science by the directors of industrial establishments there science itself gains another advantage. A scientific man can be almost sure, if he wants in his investigations the help of such technical means as only great works can afford, that he will get such assistance at once on application to any work; and the scientific papers of German chemists very often contain acknowledgments, with due thanks, of considerable help they have thus obtained.

Besides these advantages for the development of scientific and technical chemistry in Germany there exists another very important factor—practical assistance from the Government. Universities are in Germany affairs of the State, not of the Empire, and in no other point has the division of the Fatherland into many smaller countries proved itself to such a degree a boon and a blessing. The essential character of the German universities, the freedom conferred by the independence of the numerous universities, is never lost. There have been hard times occasionally for the universities of one country or another; but some universities were always to be found where even in times of hard oppression liberty of teaching and learning remained complete and unaffected, and the spirit of pure unalloyed scientific research was preserved and encouraged. So this palladium of intellectual freedom has never been lost; and it regained the former influence as soon as the casual oppression ceased. In our days there is among all the separate State Governments in Germany a clear conviction of the importance of practical support being given to pure scientific research. To take one instance, in order to facilitate teaching and research in electro-chemistry (a recently developed branch of science) a suggestion by some leading practical scientific men to the members of the Government was sufficient. Upon such a suggestion a considerable sum of money was spent first by the Prussian Government for the endowment of electro-chemical chairs and laboratories in the three "polytechnic" colleges of that country. A short time afterwards it was resolved to erect at one of the universities (Göttingen) an institute for physical chemistry, and especially electro-chemistry, in the shape of a building which has just been completed. At the same time, other German countries have begun to grant to their universities and technical colleges considerable sums of money for similar purposes, *e.g.* the Saxon Landtag alone has unanimously voted half a million marks (= £25,000) for the erection of a splendid laboratory for physical chemistry at Leipzig.

You will excuse my boasting about our German management of this most important question of scientific education. It is no blind admiration without criticism, for I know by practical experience the management in other countries, and I can compare them. And it is only for the sake of science itself that I write these lines. If they should help the spread of the conviction of the incomparable practical usefulness of every support given to pure science, together with the recognition of the fact that the latter can only grow in an atmosphere of liberty and confidence, I should regard it as tending towards the progress of science itself, and destined to exercise such an influence on scientific progress as may be compared with the discovery of the most remarkable scientific fact.

THE HOMOGENEITY OF ARGON AND OF HELIUM.[1]

THE question of the homogeneity of argon has been discussed by Lord Rayleigh and one of us in their memoir on Argon (*Phil. Trans.*, A, p. 236, 1895). But at that epoch the data were not sufficiently numerous to enable us to arrive at very definite conclusions. The discovery of helium and the analysis of its spectrum by Runge and Paschen (*Sitzungsberichte d. Akad. d. Wissenschaften*, pp. 639 and 759, Berlin, 1895) lead to the thought that this body may be a mixture of two gases.

To elucidate this question we submitted these two gases to a methodical diffusion, causing them to traverse a duct of porous pipe-clay submitted on one of its surfaces to the action of a vacuum. We satisfied ourselves that we might thus effect the separation of hydrogen and helium and that of oxygen and carbonic acid, and that, by measuring the rapidity of the descent of a column of mercury introduced in the circuit of the apparatus, it is possible to arrive at a good determination of the molecular weight of various gases. We have then tried to separate argon into two parts by a method analogous to the separation of liquids by fractionated distillation.

The quantity of argon was close upon 400 c.c. The gas was then treated in the manner shown in the following scheme:—

	More diffusible.			I.		Less diffusible.
	$\frac{1}{2}$	. . . .			. . . .	$\frac{1}{2}$
II.	$\frac{2}{3}$	. . . .	$\frac{1}{3}$	$\frac{1}{3}$	. . . .	$\frac{2}{3}$
	$\frac{1}{2}$	. . . .			. . . .	$\frac{1}{2}$
III.	$\frac{2}{3}$	. . . .	$\frac{1}{3}$	$\frac{1}{3}$	. . . .	$\frac{2}{3}$
	$\frac{1}{2}$	. . . .			. . . .	$\frac{1}{2}$
IV.	$\frac{2}{3}$	. . . .	$\frac{1}{3}$	$\frac{1}{3}$	. . . .	$\frac{2}{3}$
	$\frac{1}{2}$	. . . .			. . . .	$\frac{1}{2}$

We determined the density of the two extreme portions, and found that the one which ought to be the lightest had the density (O = 10) of 19·93, and the heaviest of 20·01. The separation, if it takes place, is therefore minimal.

The same experiment executed with helium yielded other results. The density of the specimen which passed first was 1·874, and that of the gas remaining in the apparatus 2·133. A great number of fractionations did not change these figures; even the spectra of the two specimens were absolutely identical. Even the first bubbles of the lighter gas showed the same lines, with the same intensity, as the last bubbles which remained in the apparatus. There was no difference in fifty fractions.

Lord Rayleigh has had the kindness to measure the refraction of the two specimens of gas. Whilst the lighter gives the figure 0·1350 (atmospheric air = 1), the heavier had a refraction expressed by the figure 0·1524. Now these two numbers have a relation almost identical with the relation of the densities, for—

$$\frac{0{\cdot}1350}{0{\cdot}1524} = \frac{1{\cdot}874}{2{\cdot}110} \text{ in place of } \frac{1{\cdot}874}{2{\cdot}133}$$

Let us now consider what happens when we submit a mixture of the two gases to diffusion. Let us take, *e.g.*, a mixture of hydrogen with an excess of oxygen. After a sufficient number of operations we obtain pure oxygen on the one hand, and on the other a mixture of 1 part of hydrogen with 4 parts of oxygen. It will not be possible to separate this mixture into its constituents, on account of the equal diffusion of oxygen and hydrogen when thus mixed. The identity of the spectra of helium prevent us from deciding which is the pure gas and which is the mixture. Calculation establishes that if we suppose the heavier gas is a mixture, the density of the lighter, supposed pure, ought to be 1·58. Helium, lastly, if it consists of a mixture of two gases, is formed either of two gases of the densities

[1] A paper presented to the Paris Academy of Sciences on July 27, by Prof. W. Ramsay and Dr. J. Norman Collie. (Reprinted from the *Chemical News*.)

2·366 and 1·874, or two gases of the densities 2·133 and 1·580.

But although this explanation is the most suitable, there exists another which deserves our attention. The spectrum of these two fractions shows no difference. It is not probable that two gases exist the densities of which are so near each other. The different gases do not possess a refraction proportional to their densities. It seems to us that we might admit that we have effected a real separation of the light mols. from the heavy mols. The idea that all the mols. of a gas are homogeneous has never been submitted to the test of experiment. We do not know of any attempt at a separation of this kind of a gas regarded as homogeneous into two different parts. But our experiments show that this question deserves to be studied. If it can yield us similar results we must change our ideas on the nature of matter.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Marquis of Bute has signified his intention of contributing £10,000 to the University of South Wales, to be applied for the purposes of technical education in Wales, the sum to be handed over to the authorities as soon as required. The Drapers' Company have also promised £10,000 towards the fund for providing new buildings, and the Government have promised £20,000 on condition that an equal amount is raised by public subscriptions.

APROPOS of the complaint from the *Local Government Journal* referred to last week, we see in the recent report of the Somerset County Council that "manual instruction in agricultural processes has made no progress." Though some successful classes in sheep-shearing, thatching, and hedging have been held at a few centres, Committees that have endeavoured to organise instruction of this kind report, as a general rule, that they have been unable to obtain from the farmers that support and co-operation which is indispensable if the work is to be carried out successfully.

WE notice in the report of the Technical Education Committee which was adopted by the Northumberland County Council at their recent meeting, that it has been decided to renew the grant of £500 to the Agricultural Department in the Durham College of Science on the following conditions, which differ somewhat from those which obtained last session:—The college is to undertake the direction of the school of agriculture and demonstration farm in accordance with the Technical Education Committee's requirements, as well as to arrange and supervise not less than six manurial trial stations at local centres in Northumberland, and to arrange for as many as sixty lectures, examinations, or inspections in agriculture and dairy work. On the other hand, the farm in Northumberland is to be open to the students of the Durham College of Science at times which are to be specified. This mutual arrangement should prove very beneficial.

THE East Sussex Committee for Technical Instruction complain that attention is given too exclusively to elementary science teaching in the various classes throughout their county, and that scarcely any work of an advanced character is attempted. This is bad, but it will be much worse if they attempt advanced teaching too soon. A completely new form of agricultural instruction has been undertaken by the authorities of the agricultural school at Uckfield, which is maintained by this Committee. The students are taken to many of the sales of agricultural implements and produce which occur in the neighbourhood, as well as to the fortnightly cattle auctions. The idea, which is to give the students an acquaintance with current values of farm and live stock, seems to have some good in it, though considerable discretion will have to be used by the instructors to prevent erroneous notions being imbibed by the students.

THE programme of the Princeton University sesqui-centennial celebration has just been announced as follows:—Tuesday, October 20, commemorative religious services in Marquand Chapel, discourse by President Patton; reception and introduction of delegates in Alexander Hall; probably a musical concert in Alexander Hall, not yet fully arranged, and some other suitable event may be substituted. Wednesday, October 21, Alumni Day, oration and poem in Alexander Hall, Prof. Woodrow Wilson, orator; Rev. Dr. Henry Van Dyke, poet; reception by President and Mrs. Patton at Prospect; students' torchlight procession and illumination of the campus; addresses from the steps of Nassau Hall, and student songs by alumni and undergraduates. Thursday, October 22, one hundred and fiftieth anniversary day; the sesqui-centennial celebration, academic procession marches to Alexander Hall; announcement of university title; announcement of endowment secured; conferring of honorary degrees, and other appropriate ceremonies; farewell dinner to the invited guests in Alexander Hall.

THERE are, it seems, only twelve scholars at the Swanley College in Kent, including six who hold scholarships which have just been awarded. Since the Kent County Council are bound to pay for twenty pupils as a minimum, the Technical Education Committee desire a more satisfactory state of things, and have recommended an entire reconstruction of the college. Nor is everything quite what is desired in Berkshire. The lectures for teachers provided by the education authority in this county cost £550 a year, yet it is reported that there is a want of appreciation of the value of the courses on the part of those for whom they are intended. Moreover, the object for which the lectures were instituted, viz. the provision of teachers to hold evening continuation schools, has not been attained. The Committee for Technical Instruction has therefore recommended that no new students be admitted for attendance at science lectures, but that the three years of existing students (if duly qualified) be completed. It is further complained that teachers have not availed themselves of the good work which is being done at the Reading University Extension College.

THE Programme of Technological Examinations of the City and Guilds of London Institute (Whittaker and Co.) furnishes abundant information on the valuable work which the Institute is doing for technology and manual training. The programme contains the syllabuses of the sixty-six subjects in which examinations are now held (a helpful list of works of reference being given at the end of each), and the examination questions set this year. Among the changes in the Institute's programme, we notice the following:—The subject of "Brickwork and Masonry" has been divided into two, "Brickwork" and "Masonry," and a practical examination, to be held in London, has been added to each. The regulations for the examination in "Photography" have been altered. In future, all candidates will be required to pass a local practical examination before being admitted to the written examination in the ordinary grade. The syllabus in "Paper Manufacture," in "Pottery and Porcelain," in "Boot and Shoe Manufacture," in "Dressing of Skins," in "Cotton Spinning," has been re-written. In several other subjects the syllabus has been altered. Provision has been made for admitting, under certain conditions, teachers of secondary schools to the manual training examinations.

THE report of the Somerset County Education Committee for the financial year ending March 31, 1896, gives abundant evidence of the accomplishment of much good work. The plans of the Committee are laid upon a carefully thought-out basis, and reflect no small credit on the wisdom of their organising adviser. These arrangements have been the same as in previous years, with the exception of discontinuing the courses of University Extension Science Lectures, which has meant a saving of more than £1000 per annum. We are glad to notice that the Committee are able to report that the work as a whole "shows a distinct and satisfactory tendency to develop along certain well-marked and permanent lines, with a corresponding reduction in the number of classes of a more or less ephemeral character." In no case has an evening continuation school been reported to them by the inspectors as generally inefficient; and "there is a general tendency towards an increase in the average attendances" in all of the 141 of these schools. As regards the work in the secondary schools of the county, many of which have been substantially aided by the Committee, it has been rightly laid down "that the best foundation for technical instruction is a really good secondary education sufficiently comprehensive in its character to include, in addition to the ordinary English subjects, natural science, mathematics, modern languages, drawing, and some manual training, and it is with a view to place an education of this kind at moderate fees within the reach of all in the county who wish to avail themselves of it, that the County Committee gives the aid specified." It is not to be wondered at, after so sensible a declaration, that the report is able to call attention to excellent results from all divisions of their administrative area.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, June 18.—Mr. A. G. Vernon Harcourt, President, in the chair.—The following papers were read :—The action of bromine on pinene with reference to the question of its constitution, by W. A. Tilden. The author experimentally confirms his view that one molecule of pinene can combine with four atoms of bromine, and proposes a new formula for the hydrocarbon.—Preliminary note on some products from pinene tetrabromide, by W. A. Tilden and A. Nicholls.—An apparatus for showing experiments with ozone, by G. S. Newth. The author describes an apparatus for showing the action of reagents on ozonised oxygen, the reagent being introduced in such a way that the volume of the gas is not disturbed.—Note on santalal and some of its derivatives, by A. C. Chapman and H. E. Burgess. It is shown that cedrene and the hydrocarbon obtained by the action of phosphorus pentoxide on santalal are very similar but not identical.—Second note on the liberation of chlorine during the heating of a mixture of potassic chlorate and manganic peroxide, by H. McLeod. The author confirms his previous observation that the gas obtained by heating potassium chlorate with manganese dioxide contains small quantities of chlorine, but no ozone.—Polymorphism as an explanation of the thermochemical peculiarities of chloral and bromal hydrates, by W. J. Pope. The fact that the heat of dissolution of chloral hydrate is partly dependent on the length of time elapsing since solidification, is shown to be due to a change in crystalline form of the solid substance.—Explosion and detection of acetylene in air, by F. Clowes. Mixtures of air with 3—81 per cent. of acetylene are explosive ; the best method of estimating acetylene in air is based on the examination of the change occurring in a hydrogen flame when such air is passed over it.—On the occurrence of quercitin in the outer skins of the bulb of the onion (*Allium Cepa*), by A. G. Perkin and J. J. Hummel. The colouring matter present in the skin of the onion bulb is shown to be quercitin.—On the colouring matter contained in the bark of *Myrica nagi*, by A. G. Perkin and J. J. Hummel. The bark of *Myrica nagi* contains a colouring matter $C_{15}H_{10}O_8$, which the authors term myricetin ; it is probably a hydroxyquercitin.—Preliminary note on a new base derived from camphoroxime, by M. O. Forster. By treatment with methylic iodide, camphoroxime yields campholenonitrile together with the hydriodide of a new tertiary base, $C_{12}H_{19}N$; a number of compounds of the latter have been prepared.—The rotation of aspartic acid, by B. M. C. Marshall.—Synthesis of pentacarbon rings. Part iii. Condensation of benzil with lævulic acid, by F. R. Japp and T. S. Murray. Benzil and lævulic acid condense yielding two isomeric anhydrobenzillævulic or diphenylhydroxycyclopentenonylacetic acids ; the derivatives and decomposition products of these acids are described.—Absorption of dilute acids by silk, by J. Walker and J. R. Appleyard.—Position-isomerism and optical activity ; the methylic and ethylic salts of ortho-, meta-, and para-ditoluyltartaric acid, by P. Frankland and F. M. Wharton.—Double sulphides of gold and other metals, or the action at a red heat of sulphur upon gold when alloyed with other metals, by J. S. Maclaurin.—The relative weights of gold and silver dissolved by potassium cyanide solutions from alloys of these metals, by J. S. Maclaurin.—The three chlorobenzeneazosalicylic acids, by J. T. Hewitt and H. E. Stevenson. Ortho- and para-chlorobenzeneazosalicylic acids have been prepared by the action of diazotised chloraniline solution on salicylic acid ; derivatives and salts of the three isomerides are described.—Condensation of chloral with resorcinol, by J. T. Hewitt and F. G. Pope. The condensation of chloral and resorcinol yields a tetrahydroxydiphenylacetic acid and its lactone.—The atomic weight of Japanese tellurium, by Masumi Chikashigé. The tellurium of which the atomic weight has previously been determined has been obtained from metallic tellurides ; if tellurium be a compound, as has been suggested, that obtained from Japanese tellurosulphur should have a different atomic weight. The author finds, however, that tellurium from the latter source has the same atomic weight as that prepared from tellurides, and consequently concludes that this element really has a greater atomic weight than iodine.—Derivatives of camphene sulphonic acids, by A. Lapworth and F. S. Kipping. The α- and β-chlorocamphenesulphonic chlorides obtained during the sulphonation of camphor, and their derivatives, are described.—Iodoso- and iodoxybenzaldehydes, by V. Meyer and T. S. Patterson.—α-Isopropylglutaric acid, by W. H. Perkin, jun.—The action of ethylic β-iodopropionate on the sodium derivative of ethylic isopropylmalonate, by T. Z. Heinke and W. H. Perkin, jun.—The condensation of halogen derivatives of fatty ethereal salts with ketones and ketonic acids, by W. H. Perkin, Jun., and T. F. Thorpe.—The electrolysis of the salts of monhydroxy-acids, by J. W. Walker.—The action of formic aldehyde on phenylhydrazine, and on some hydrazones, by J. W. Walker.—The colouring matter of Sicilian sumach, *Rhus coriariæ*, by A. G. Perkin and G. Y. Allen. The colouring matter of Sicilian sumach is not quercitin or quercitrin, but myricetin.—The colouring matter of *Quebracho Colorado*, by A. G. Perkin and O. Gunnell. The colouring matter of querbracho is fisetin.—On asitine, the alkaloïd of *Aconitum heterophyllum*, by H. A. D. Jowett. Asitine is amorphous and non-toxic, and probably has the composition $C_{22}H_{31}NO_3$; many of its salts are described.—The action of methyl alcohol on aconitine. Formation of methyl benzaconine, by W. R. Dunstan, T. Tickle, and D. H. Jackson.—The chemical inactivity of Röntgen rays, by H. B. Dixon and H. B. Baker. The authors have investigated, with negative results, the question whether Röntgen rays are able to influence chemical change, either by starting it or by accelerating or diminishing it after it has been started by ordinary light.—Colloïdal chromsulphuric acid, by H. T. Calvert and T. Ewan.

BOOKS RECEIVED.

BOOKS.—The Theory of National and International Bibliography : F. Campbell (Library Bureau).—Forty-third Report of the Department of Science and Art (Eyre).—Durham College of Science, Calendar for Session 1896-7 (Reid).—Sixteenth Annual Report of the U.S Geological Survey, Parts 2, 3, 4 (Washington).—The Boston Machinist : W. S. Fitzgerald, 4th edition (Chapman).—Steel : W. Metcalf (Chapman).—A Guide to Chamonix, &c. : E. Whymper (Murray).—Accounts of Trade carried by Rail and River in India, 1894-5, &c. (Calcutta).—City and Guilds of London Institute, Programme of Technological Examinations, Session 1896-7 (Whittaker).—Signaletic Instructions, including the Theory and Practice of Anthropometrical Identification : A. Bertillon, translated (Paul)—The Indigenous Drugs of India : K. L. Dey, 2nd edition (Thacker).—Lehrbuch der Experimental Physik : Prof. E. Riecke, Zweiter Band (Leipzig, Veit).

CONTENTS.

THURSDAY, SEPTEMBER 3, 1896.

AN AMERICAN PROFESSOR.

Memoirs of Frederick A. P. Barnard, D.D., LL.D., &c., Tenth President of Columbia College in the City of New York. By John Fulton. Pp. xii + 485. (New York: published for the Columbia University Press by The Macmillan Co. London: Macmillan and Co., Ltd. 1896.)

THE name of Barnard is honourably associated with the history of education in the United States. To English readers, the best-known bearer of the name is the Hon. Henry Barnard, formerly United States Commissioner of Education, and now living in retirement at Hartford, Connecticut. As the author of numerous local and special reports, and the compiler of valuable statistics and monographs on the various aspects of public instruction; and particularly, as the editor of four or five massive volumes containing reprints of standard treatises on the philosophy and history of education in England and Germany, he has done more than any man in the American Union to promote the study of pedagogical literature.

The present volume recounts the history and doings of one who is less generally known on this side of the Atlantic—the Rev. Frederick A. P. Barnard, a versatile, fluent, and vigorous man who filled with credit many academic offices, and exercised considerable public influence, both within and without the college and university world of America. He was born in 1809, and graduated at Yale 1828, became tutor in 1829, teacher in the asylum for the deaf and dumb at Hartford and in that of New York, his own interest in children thus afflicted being greatly enhanced by the defect of hearing which troubled him through life, and which he manfully strove to fight against. In 1837 he was professor of mathematics and natural philosophy in the University of Alabama, and afterwards of chemistry, remaining in that University till 1854, when he took orders in the Episcopal Church, and became professor of mathematics and astronomy in the University of Mississippi, becoming its president in 1856. He removed to Columbia College in 1864, subsequently served as United States Commissioner to the Paris Expositions of 1847 and 1878, and wrote for the former an elaborate report on machinery and the industrial arts. His versatility and many-sided interests are well illustrated by the facts that he occasionally served as professor in literature and history, and that his published works include a treatise on arithmetic; an analytic grammar with symbolic illustration descriptive mainly of a system designed for the use of the deaf and dumb; letters on Collegiate Government, 1855; history of the United States Coast Survey, 1857; recent progress of Science, 1869; and the Metric System, 1871. Although no scientific observation or discovery of an original kind can be ascribed to him, he was a member in 1860 of the astronomical expedition to observe the total eclipse of the sun in Labrador, in 1862 he was engaged in continuing the reduction of the observations of the stars in the southern hemisphere by Gillis, and in 1863 had charge of the publication of Charts and Maps of the United States Coast Survey. He served in 1860 as President of the American Association for the Advancement of Science, and in 1872 of the American Institute. He received honorary degrees from Jefferson College, Missouri, from Yale and from Mississippi, and also that of Doctor of Literature from the University of the State of New York. During part of his life he served as editor of a review, and was a frequent contributor to newspapers and magazines, both in prose and verse.

The pious care of his widow in collecting his speeches and reports, and the facile pen of his biographer, Mr. Fulton, have produced a large volume of nearly 500 pages, which, though containing many facts illustrative of the growth of higher education in America, and much information respecting significant but ephemeral academic controversies, strikes the English reader as somewhat disproportioned to the amount of Barnard's actual achievement and force in the world. A due sense of historical perspective, and of the difference between what is temporary and what is permanent in a human life, is one of the highest and, it must be owned, one of the rarest qualifications of a biographer. Had it been possessed by the author of this volume, the narrative might with great advantage have been reduced to half its present length.

Barnard's views about the purpose of education, though not novel, showed insight and good sense.

"It has always seemed to me," he said, "to be the great, as it is the almost universal, educational mistake of our time, that children, instead of being introduced to subjects which address the perceptive faculties, and which are adapted to furnish them with a flood of novel and clearly comprehensible ideas, are usually condemned to the dreary study of unintelligible words, which impose a heavy burden on the memory, and are only apprehended after the understanding has become matured with advancing years."

He saw also, with greater clearness than many of his associates, the intellectual dangers of that "elective system" which has obtained so much favour in the States, and the confusion which would arise, especially in small colleges, "if every student were allowed to study what he chose, all that he chose, and nothing that he did not choose." He insisted with much force that the demand for such options "did not proceed from a genuine desire for special or partial instruction, but simply and solely from the ambition to obtain the college stamp of scholarship without submitting to that severe and systematic intellectual training which alone can make the scholar."

Of his resolute opposition to Slavery, and of his sympathy with the party of Union in the Civil War, notwithstanding the prevalent feeling among his neighbours in the South, the volume gives an interesting account. It was not till his removal to Columbia College in New York, that he acquired full freedom to carry into effect his views on academic organisation and reform without being hindered by quasi-political opposition or distrust. At fifty-five years of age he was elected to the presidency of that institution, which, though with an interesting history and considerable resources, had hardly entitled itself to the rank of a university. By the development of a School of Mines and the Schools of Law and of Medicine, and especially by the provision of new means and encouragement for post-graduate research, Barnard did much to

vindicate the claims of Columbia College to that rank, and to secure for it increasing repute and public usefulness. He urged on the Trustees the importance of making the College available for the advanced education of women, and succeeded after long and arduous effort in establishing what is now known as the Barnard Annexe to the College, a feminine institution practically under the care of the same professors, and aiming at the same academic course. In 1882 he took the first steps in a movement with which the name of Dr. Murray Butler has since been conspicuously associated for establishing a professorship in the literature, history, and art of Education, and for securing professional training for those students who intended to become teachers. On the whole the book, though diffuse in style and encumbered with some needless detail, is a useful contribution to educational history. It is the record of a strenuous and honourable life, of high and generous aims often obscured by discouragement, but ever kept steadily in view, and of a considerable number of experiments, both in regard to instruction and discipline, which have done much to render the solution of educational problems easier, especially in America. J. G. FITCH.

APPLIED CHEMISTRY OF NITRO-EXPLOSIVES.

Nitro-Explosives. By P. Gerald Sanford, F.I.C., F.C.S. Pp. xii + 270. (London: Crosby Lockwood and Sons, 1896.)

WE had lately under our notice a work on explosives which dealt with their manufacture more from an engineer's point of view than from that of a chemist, and consequently the various appliances were described with a detail which only a practical engineer could properly express. In the present volume the processes are placed before us exclusively from a chemist's point of view, and the appliances and machines used receive generally but a brief notice; indeed, some fifty sketches is the sum total of the illustrations covering the apparatus used in the manufacture of the numerous nitro-compounds touched upon in the book. Of these sketches a considerable number are of different pieces of chemical apparatus made use of in testing the raw or finished material.

The author first briefly considers some of the chemical groups from which the nitro-compounds are formed, and, in doing so, volunteers the statement that "the nitro-explosives belong to the so-called High Explosives." This, however, depends very much on whether these explosives are intended to be used as disruptive agents for producing local effect, or as propelling agents. In other words, taking Hess's definition, a high explosive is one which requires the use of a detonator to develop its full value, as with guncotton or dynamite; a low explosive, as gunpowder, does not require a detonator, but will exert its full power by simple ignition. Here again, however, we require to make some qualification as, although all the nitro-explosives are high explosives in one sense, it depends on whether they can, or cannot, be detonated in order that we may define them as high explosives pure and simple, or as explosives of high energy. Practically speaking, only the latter are suitable for propelling or ballistic purposes, while the former class should be used as blasting agents only. An explosive which can be detonated by a detonator, can also, by suitably confining it, be often exploded by a simple ignition in such a manner that its explosion really becomes a detonation, or partakes of the nature of a detonation, *i.e.* very high local pressures are developed. It is, therefore, a matter of considerable importance to definitely ascertain that explosives to be used as ballistic agents cannot be detonated.

The chief value of the book depends on those portions dealing with the manufacture of nitro-glycerine, dynamite, and guncotton, and the testing of the raw and finished material. The descriptions relating to these explosives show very evidently that the author has personally participated in their manufacture, and his remarks, which are generally to the point, are consequently of considerable value to chemists and others engaged in similar operations. Mr. Sanford very properly lays much stress on the testing of the materials used in all the stages of manufacture, and it will be found that nearly as much space has been devoted, in different parts of the book, to testing and analysis as to the actual manufacture of the explosives. Unfortunately, the reader is credited with being already more or less familiar with the appliances connected with the manufacture of explosives, and therefore the author apparently considers that a brief notice is all that is necessary. Nitro-glycerine and nitro-cellulose have, however, become so important in connection with civil and military undertakings, that those who employ such explosives are glad to be able to read an interesting account which is trustworthy without being exhaustive, and which does not make too great a demand on the pocket. To such this book is especially recommended, as these substances receive the greatest share of attention, and they form the basis of the more powerful and popular blasting materials, and also of practically all the smokeless powders used in small arms or artillery; but, besides these uses, nitro-cellulose (collodion-cotton) is employed to a very large extent in the production of that most useful material called celluloid, xylonite, or imitation ivory, of which so many articles of every-day life are made, such as knife-handles, buttons, photographic dishes, and billiard balls. The manufacture of this substance forms one of the most interesting portions of the book, and, although not properly coming under the category of an explosive, it finds a fitting place in this work.

It must not, however, be forgotten by those who make use of celluloid that it becomes, under certain conditions, a powerful explosive. Celluloid shavings also should never be allowed to accumulate, as they take fire easily at a comparatively low temperature, and, in this state, burn with surprising rapidity.

In the analysis and testing of explosives, to which, as we have stated above, due prominence has been given, the various operations are briefly but concisely explained. They are evidently written for the use of practical chemists, and will, no doubt, be duly appreciated by them. With regard to the heat or stability test which is applied to most explosives before they are passed for service, it has lately been put beyond doubt that the sun's rays have a marked effect on some explosive substances,

thereby shortening very materially the length of time they are able to stand the test, without, however, undergoing any other suspicious change; indeed, if they be subsequently allowed to stand for a time in a cool place out of the reach of white light, they recover their apparently lost property, and stand the heat test as well as ever.

The effect of sunlight on both guncotton and nitroglycerine has long been known, but it is only lately that this important point has received much consideration in Government and private factories. Care is now taken to screen off direct sunlight, or even white light, by some non-actinic material placed over the windows.

We feel constrained to make a few remarks on one other point, viz. the author, in detailing the various advantages claimed for a certain smokeless powder, states that it gives *lessened recoil* and *high velocity*. Now these are very common advertising phrases of no practical value, as the recoil of a gun is nearly proportional to the velocity of the projectile, by a well-known law of dynamics. Taking the figures given—38 grains of the particular powder referred to was necessary to obtain the same velocity (about 2000 f.s.) as the service charge of cordite, 31 grains in the Lee-Metford rifle with a 215 grain bullet. Now

$$\text{Velocity of recoil} \times \text{weight of gun}$$
$$= \text{velocity of bullet} \times (\text{weight of bullet} + m \text{ weight of charge}),$$

m being a factor, which is found by experiment to be practically constant.

It will be seen at once that, other conditions being equal, the heavier charge must give the greatest recoil.

H.

THE PRACTICE OF MASSAGE.

The Practice of Massage; its Physiological Effects and Therapeutic Uses. By A. Symons Eccles, M.B. Aberd. Pp. 377. (London: Macmillan and Co., 1895.)

THE rubbing and kneading of the surface of the body, and various modifications of such processes for the relief of pain, have been in vogue from time immemorial in many countries, both civilised and uncivilised. It is well known, indeed, that the natives of India have always largely employed such measures, and that even among the aboriginal tribes of America something of the kind has been practised. Mechanical frictions and rubbings were included by Hippocrates and Galen in their systems of therapeutics, and in some form or shape they have ever since been in use in the older spas and baths of Europe. But although the practice is so ancient and so widespread, its admission into modern medicine as a recognised means of treating disease only dates from the present century, and the literature of the subject—now comparatively large—may be said to have had little or no existence fifty years ago. The Scotch and French physicians seem to have been the first in modern times to investigate the subject scientifically; and it is to the latter, in particular, that we owe the systematic ways of application of the various manipulations now in use, as well as the nomenclature which is now practically universally adopted by practitioners in all civilised countries. Within the last few decades a considerable number of valuable observations on the uses and effects of massage have been published, as well as several comprehensive text-books on the subject. Among these latter, the work now before us is likely to take an important position; for not only is it the outcome of a lengthy and extensive practical experience on the part of the author, but it is written in a scientific spirit, and, indeed, constitutes a very able *résumé* of the whole subject.

Dr. Eccles commences by describing the different manipulations and the methods of applying massage in general, as well as to particular parts of the body. In the second chapter, he treats of the physiological effects of massage; and it is in this department that we naturally feel most interest. As might be expected, the effects vary with the kind of manipulation; thus gentle "effleurage," or skin stroking, will give rise, first, to a pilo-motor reflex, or condition of "goose-skin," and if firmer friction be employed, a dilatation of the superficial cutaneous vessels is produced, followed by increased activity of the sweat glands. The direction of the stroking being centripetal, the contents of the superficial veins and lymphatics are forced along, and the rapidity of the cutaneous circulation increased. Among the important results of effleurage, the author mentions a general soothing effect on the nervous system, and an acceleration of the heart-beat. With the process of "pétrissage," or the kneading, rolling, and squeezing of the integuments and underlying tissues, it is shown that the circulation of the skin and contiguous muscles is still more accelerated, the absorption of waste products promoted, and the general nutrition of the parts improved. Muscle-kneading thus serves as a substitute for muscular exercise, and also as a restorative of fatigued muscle. The experiments of Lauder Brunton and Tunnicliffe on the effects of massage on blood-pressure are here alluded to, as well as the author's interesting observations on the results of muscle-kneading on the temperature of the body.

"Tapotement," or the delivery of a rapid succession of blows, produces its principal effect through the direct stimulation of the nerve trunks; localised muscular contractions are induced; and if applied over a molar nerve, the muscles supplied by that nerve are profoundly affected. The author observes, moreover, that stimulation of the sensory nerves by this "muscle-hacking" while producing increased temperature and vascularisation of the part so treated, may also give rise to symmetrical reflex secretion. The various movements classed under the head of "vibrations," are also designed to act mechanically on the subjacent nerves, and thereby to produce reflex effects of a sedative character. The author has frequently, for instance, observed relief following nerve-vibration in non-inflammatory abdominal pain. The so-called "massage à friction," especially used for the manipulation of joints, is a combination of rubbing and kneading, having for its purpose the dissipation and squeezing out of waste products from the tissues in which they have accumulated; and in this connection von Mosengeil's experiments are quoted, which show conclusively that artificial injections in a joint can be removed by massage, and forced into the ascending lymphatics.

The succeeding chapters of the book treat of the

therapeutical uses of massage in affections of the skin, of the muscles, in rheumatism, sprains, dislocations and fractures, disorders of digestion, anæmia, obesity, nervous affections, insomnia, heart diseases, and in many other maladies in which mechanical manipulations, intelligently and skilfully employed, have been proved to be efficacious after other means of treatment have failed.

The author gives, throughout his work, succinct and practical directions, which will prove of the greatest use to those practitioners who have had no experience of a treatment which is now generally accepted in the medical profession as one of the most useful in therapeutics.

OUR BOOK SHELF.

Catalogue of the Fossil Bryozoa in the Department of Geology, British Museum (Natural History). The Jurassic Bryozoa. By J. W. Gregory, D.Sc., F.G.S., F.Z.S. Pp. 239; pl. xi. (London: 1896.)

THIS catalogue is a valuable addition to the twenty-two monographs which have already been devoted to the various groups of fossils preserved in the Geological Department of the Natural History Museum. The Trustees of the British Museum have earned the gratitude of palæontologists, and of naturalists generally, by bringing together such a wealth of information upon the fine collections under Dr. Henry Woodward's care.

In an introduction, Dr. Gregory discusses the problem of tubular fossils, the affinities, and the structure of Bryozoa, the terminology of the shells of the Cyclostomata and Trepostomata, and the value of generic divisions in the latter order. In this section, the differences of opinion between those who attribute generic value to trivial differences, and those who prefer to restrict the number of genera, are described. The discussion of transitions traced in groups of Cyclostomata, leads to the examination of the question whether there are really genera and species among Cyclostomatous Bryozoa. Taking the genera *Diastopora* and *Berenicea* as exemplifying the real value of zoarial characters in the order, they seem to support the admission that "there are no true genera among Cyclostomata, but only certain convenient, but artificial, groups of species. . . . I therefore accept the terms *Stomatopora*, *Proboscina*, &c., as names for convenient groups, which are not altogether artificial, but which are not genera in the sense in which that term can be used among Echinoidea and Mammals. They could be better described as circuli than as genera."

From the subject of generic divisions, Dr. Gregory passes to specific groups and individual variations. The comparison of the forms of Bryozoa that lived in successive geological periods, appear not to lend support to Mr. Bateson's views as to discontinuous variation. "The general evidence of the fossil specimens," says Dr. Gregory, "and the great difference of opinion as to the range of specific variation between those who multiply species indefinitely, and those who place Silurian and recent individuals in the same species—tend to show that most of the forms of Cyclostomata have arisen by slow, imperceptible, continuous variation."

With the exception of two species (both members of the order Cheilostomata), all the Jurassic Bryozoa belong to the order Cyclostomata. This order is classified by Dr. Gregory into four sub-orders, viz.: I. Articulata; II. Tubulata; III. Dactylethrata; IV. Cancellata. The first of these groups is not represented in the Jurassic, and species of the fourth group do not appear until the Cretaceous period. The names of the second, third, and fourth groups are based upon zooecial structure, while the subdivisions of the groups depend upon zoarial characters.

From the foregoing outline of the teachings of Dr. Gregory's examination of the Bryozoa of Jurassic times, it will be concluded that the catalogue furnishes facts of distinct value in working out the evolution of the class. Eleven plates, containing many admirable drawings of the species described, have been prepared for the catalogue by Miss G. M. Woodward. These, with the careful determinations and critical introduction, make the catalogue not only most acceptable to all palæontologists, but also of the greatest interest to systematic zoologists.

Water Supply (considered principally from a Sanitary Standpoint). By Wm. P. Mason. Pp. 504. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1896.)

THIS is an unusually interesting treatise on a technical subject, about which so much has been already written, and the author is to be congratulated on the large amount of new information which he has succeeded in compressing into a comparatively small volume without rendering it heavy and unreadable. The book is full of facts gathered from the most varied sources, so that even the expert in this department of knowledge will find it a convenient work of reference, whilst it may also be perused with great profit by that large and ever-increasing body of laymen who, as medical men, members of local boards, landlords, and the like, are supposed to have some acquaintance with this subject, and whose responsibilities in this connection are generally out of all proportion to their knowledge. Prof. Mason has collected the results of the principal investigations bearing on the sanitary aspects of water supply, made both in Europe and America, and European readers should be specially grateful to him for the lucid and concise manner in which he has summarised and abstracted the important trans-atlantic labours in this direction, and the original description of which is only to be found in comparatively inaccessible and exceptionally voluminous writings of an official character. There are many points in connection with the sanitary aspects of water supply, on which, as is well known, the most conflicting opinions are prevalent amongst experts, and not the least commendable feature in this work is the impartiality and fairness with which the author has marshalled and reviewed the evidence adduced by the contending parties.

Botany for Beginners. By Henry Edmonds, B.Sc. Pp. 117. (Longmans, Green, and Co., 1896.)

THE author hopes that this little botany primer "may be the means of exciting an interest in the subject in the minds of the young." He is a teacher, and should therefore know that a multitude of new names is the reverse of exciting to young students, yet this is how the definitions are crowded in on page 3: "They [certain leaves] are spoken of as **radical** leaves (Latin, *radix*, a root). Others are attached to the stem, and are described as **cauline** (Latin, *caulis*, a stem). The radical and lower cauline leaves possess a stalk, or, as it is called, a **petiole.** This attaches the flattened part, or **blade**, to the stem. The upper cauline leaves have no such stalk, the blade being immediately attached to the stem, or **sessile.**" And again on page 5: "Each of these is called a **carpel**, while the group of carpels is termed the **pistil.** Each carpel consists of a swollen portion, the **ovary**; on top of this there is a little head. the **stigma.**" This is all very well, and the language of botany must, of course, be learned at some stage or other; but, at the same time, the designations follow one another so closely, that the pupils who use the volume as a reading-book will get bewildered.

The book is not, however, without its good points. It is liberally illustrated, the descriptions refer to common British flowers, and a few simple experiments are introduced to exemplify the functions of the different organs of plants. A good teacher may make the lessons in the book interesting, but of themselves they are not very inspiring.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Utility of Specific Characters.

PROF. LANKESTER'S lucid statement in NATURE for August 20, shows that a part of his objection to my position is due to my own want of skill in stating clearly what I mean.

I am far from wishing to reject the method of imaginative hypothesis and subsequent experiment or observation. I respect that method as sincerely as Prof. Lankester himself, and although I cannot pretend to his measure of skill in using it, yet, so far as I can see, I have, in my work on the frontal breadth of crabs, employed this very method to the best of my ability. The hypothesis with which I started was, that if natural selection acted upon the frontal breadth of crabs at all, there ought to be a demonstrable difference between the percentage of abnormal frontal breadth in young crabs, and the percentage of the same abnormalities in older crabs; and I proceeded to test this hypothesis by measurement of crabs of different sizes. The result showed that a change in the frequency of abnormal frontal breadth could, in fact, be observed. The effort of imagination was here small enough, but, such as it was, it served to guide my first step; and, having made this first step, I had to formulate a second hypothesis. A diminution in the frequency of abnormal frontal breadth, with increasing size of crabs, might be due either to a selective destruction of abnormal crabs during growth, or to a modification of these crabs, by which abnormal individuals lose their abnormality as they grow. In order to decide which of these imaginative hypotheses should be adopted, I have spent a great part of the last two years in ascertaining the law of growth of crabs, so far as their frontal breadth is concerned. Setting the question of skill on one side, the only difference I can perceive between the method of this whole investigation and that of any research conducted by Prof. Lankester, is a difference in the tools employed in verification of hypotheses. The only tool which I have used has been some kind of measuring scale; and, although this kind of tool is more unpleasant to work with than those used by more fortunate persons, it does not imply any difference in the method of work.

Further, assuming the law of growth to yield evidence of selective destruction, so that change in frontal breadth is correlated with change in death-rate, I heartily agree with Prof. Lankester that a further hypothesis ought to be formulated as to the whole process connecting change in frontal breadth (and the whole group of characters correlated with it) with change in death-rate. The only step taken by Prof. Lankester, which I cannot follow, is the admission of hypotheses in which some of the factors of the problem are neglected. I should like to explain what I mean by this.

In *Carcinus mænas* I have shown that change of frontal breadth is correlated with change in several other dimensions of the exoskeleton; and I have no doubt that it is correlated also with change in the size and shape of several internal organs, such as the brain, liver, kidneys, and others. I have not measured such an oxyrhynchous crab as *Stenorhynchus*; but it is probable that the changes among internal organs correlated with change in frontal breadth, will prove to be very different in such a crab as *Stenorhynchus* from the corresponding changes in *Carcinus*.

Let us suppose, therefore, that the liver is shown to vary when the frontal breadth of *Carcinus* varies, but not when the frontal breadth of *Stenorhynchus* varies; and suppose, further, that an hypothesis is submitted as to the process by which change in the liver of *Carcinus* leads to change in the death-rate. It seems to me that, unless one of the steps in this process involves a change in frontal breadth, the hypothesis must be rejected, because one of the properties of the liver of *Carcinus* is not accounted for. The hypothesis submitted may be true of *Stenorhynchus*: but, since it neglects one of the differences between that animal and *Carcinus*, it cannot be true of both.

To put the matter in another form: suppose I wish to obtain hydrogen from sulphuric acid, I can do so by adding to the sulphuric acid a certain quantity of zinc. From a known quantity of sulphuric acid I can obtain a definite quantity of hydrogen, and I shall, in so doing, dissolve a definite quantity of zinc with the formation of a definite quantity of zinc sulphate. If, instead of dissolving zinc, I dissolve iron in my sulphuric acid, I can still obtain from it the same quantity of hydrogen, but the quantity of iron required will not be the same as the quantity of zinc used in the previous experiment, and the resulting sulphate will be different. It is, of course, impossible to form an exact hypothesis of what occurs in either of these cases, if I pay attention only to the evolution of hydrogen, and regard the formation of sulphate as an unimportant concomitant. I must in each case form a theory of the behaviour of the metal, the hydrogen, and the acid radicle; and, so far as it fails to account for any fact concerning any one of these bodies, my theory is imperfect.

In precisely the same way, it seems to me that we ought not to rest content with any theory of an animal structure which does not account for all the phenomena associated with it; so that a theory of the function of frontal breadth in a crab should, I think, involve every organ correlated with it. It may be said that such a theory is unattainable because of its complexity; and this is certainly at present true; but the habit of regarding one or other of the properties of an organ as unimportant, would for ever prevent the formation of such a theory even if it were otherwise possible.

It is this sense of the necessary complication of such hypotheses which makes me glad to assert that they are unnecessary to a knowledge of the factors of evolution. It is possible to know that change in frontal breadth in a *Carcinus*, for example, is associated with change in death-rate under the conditions of Plymouth Sound; so that those crabs in which the frontal breadth has a particular magnitude, can be known to have a greater chance of living and breeding than those of different frontal breadth. A complete knowledge of the processes associated with this relation between frontal breadth and death-rate is a thing of very great interest, and I believe, as firmly as Prof. Lankester, that every effort should be made to attain to it; but, desirable as it is, it is still not necessary in order to know that a crab's chance of living and breeding may be known by measuring its frontal breadth. It is not necessary in order that the change in mean frontal breadth may be measured from generation to generation, and the direction and rate of evolution by this means ascertained. W. F. R. WELDON.

Marine Biological Laboratory, Plymouth, August 26.

The Death of Lilienthal.

I HAVE received this authentic report of Mr. O. Lilienthal's death. If you think the letter worth publishing in NATURE, it is at your service. C. RUNGE.

Hannover, Technische Hochschule.

YOU are right in presuming that I can give you details referring to Otto Lilienthal's death, authentic as far as they can be obtained.

As early as the beginning of last spring, Lilienthal's experiments had taken a new departure. He had gradually come to the conclusion that the surfaces employed by him were not sufficient.

With a surface of twelve to fourteen square metres he could take sufficiently long flights to serve his purpose of observation and practice in strong, gusty wind, but he very rightly considered experimenting in a strong wind to be too dangerous, and with a light breeze about twenty square metres were found necessary. This enormous surface, however, could not be handled with the same certainty and exactness as the older wings, and as his system of steering consisted in shifting his weight within the surface upon which it was suspended, he had hit upon the simple expedient of placing two surfaces one above the other.

This system promised from the beginning to be a very marked advance. In former days Lilienthal had tried, over and over again, to make small paper models that would soar like birds, and had always been disappointed. Now this problem seemed to be solved. These two-story models, which resembled beetles rather than birds, soared in the most astonishing manner. He would let them off from the top of the artificial cone which he had erected at Lichterfelde, and they would take long and sometimes circuitous flights into the surrounding fields, and never showed the slightest tendency to take "headers"—a peculiarity very frequently hitherto observed in soaring models.

These experiments, therefore, seemed to prove that not only would a two-story surface be more easily steered, because a

definite shifting of the centre of gravity to one side would have a more marked effect (since the lateral extension of the whole structure was little more than half of that formerly used), but would also show a greater stability, a result all the more to be expected, as the centre of gravity of the system was placed more than a metre below the upper surface.

Experiments, which were begun without loss of time, seemed to bear out this conclusion. Lilienthal appeared to have suddenly gained in power and in the faculty of shaping his motion at will. It seemed to be only a question of time or opportunity that the great step would succeed of describing a complete circle in the air (which always appeared to us to be the key to a definite, if not complete success), when the disastrous accident occurred which has cost the bold experimenter his life.

The following is, as nearly as I can remember it, the report of the mechanic who used to build Lilienthal's wings, and to help him with his experiments.

On Sunday, August 9, Lilienthal had gone out to the village Rhinow, where he used to practise on the bare sand-hills in the neighbourhood. Nobody was with him except his mechanic. The weather was exceptionally favourable, a light wind blowing from the east with a velocity of about 5—6 m. per second.

Lilienthal had selected one of these new two-story surfaces, which, in a considerable number of trials from the artificial cone in Lichterfelde, had shown itself to be especially successful. He took one flight, by way of warming to his work, and then prepared himself for a second, and gave the word to his man to look at his watch and note the duration of the flight. The man saw him soar down until he was nearly above the foot of the hill, then suddenly a gust of wind set in, lifted him up to a height of 30 m. above the ground—according to his man's estimate—and there he stood apparently motionless in the air.

This was a frequent occurrence, and gave no cause for alarm at first; but now the man saw how Lilienthal gradually lowered the fore-edge of his wings more and more, without obtaining the desired effect of getting way forward and downward. The man felt uneasy at this, pocketed his watch, and began to run towards the spot where his master was hanging suspended in mid-air. Suddenly he saw the apparatus heeling over forward still more, and then Lilienthal came down with it with great force head foremost, rolled over once or twice after striking the ground, and remained motionless.

When the man reached the spot, he found the apparatus much shattered, but Mr. Lilienthal apparently uninjured though without consciousness. The local physician was instantly summoned, and at first declared that nothing serious had happened. Lilienthal was brought to the neighbouring inn, and within two hours recovered his senses. He seems to have felt no pain, because he immediately declared he would soon get up and continue practising. However, his arms and legs were lamed. It appears that his spine was fractured.

The man left him to the care of the physician, and took the next train to town to fetch his brother. When the brother came, he found that he had swooned again; and he did not recover his consciousness until death set in, which occurred the same night.

By publishing these lines the editor of NATURE will, I think, fulfil a duty he owes the scientific world, as well as the memory of a man who, throughout his toilsome life, applied his rare energy, courage, and ability to the solving of a problem which has hitherto baffled the ingenuity of all modern engineering.

Lilienthal, who was a successful engineer and manufacturer, has not lived to see his forty-eighth birthday. He leaves a widow and three children.

A. DU BOIS-REYMOND.

Berlin, August 24.

Laboratory Use of Acetylene.

NOW that acetylene has come so much into prominence, an instance of its use in a laboratory which possesses no gas supply may be an encouragement to any one similarly situated. Long doomed to the use of spirit-lamps, "benzoline roarers," and the like, the cheap production of acetylene has come as a great boon to us, and is now in regular use for blow-pipe work. The apparatus in use consists of an aspirator holding about fifteen litres, permanently connected with a water supply, and possessing a ¼-inch aperture exit tap (the water flows in from below to minimise absorption); at the top a three-hole rubber cork carries an upright pipe passing through the table, which serves for filling the aspirator with gas, or using the gas on the table, a second pipe goes to the blow-pipe, and a third carries an open mercury manometer. For filling the jar, the calcium carbide is placed in a four-ounce bottle closed by a cork carrying a small separating funnel from which the water drops; the gas passes to the aspirator through a wide glass tube which acts as a reversed condenser, returning most of the water vapour to the bottle. With the large exit to the aspirator the gas can always be collected under a reduced pressure of several cms. of mercury, which quite provides against any sudden rushes of gas; the operation takes some ten minutes, and requires practically no attention.

In using the gas the water is turned on with all taps closed for a few seconds, to correct any reduced pressure caused by absorption, as shown by the gauge (this is very slight indeed), and then the gas-tap fully opened and the flame regulated entirely by the water entrance. To bring the gas into use takes hardly any longer than with an ordinary gas blow-pipe. A good fusion on platinum foil (*e.g.* $BaSO_4 + Na_2CO_3$) may be effected by using about one litre of the gas. We have used the apparatus for about two months, and I recently discovered that some of my junior workers did not know what acetylene smelt like, which speaks well for it if not for them. I am hoping to introduce the gas on to the benches if the difficulty of the enormous quantity of air required to produce a non-luminous flame can be overcome.

A. E. MUNBY.

The Laboratory, Felsted School.

Coal-dust.—A Question of Priority.

IN the report of a lecture given *in extenso* at page 64, *et seq.*, in the *Colliery Guardian*, for July 10, on "Coal-dust and Explosives," by Mr. H. Richardson Hewitt, of Derby, H.M. Inspector of Mines, the following remarkable statements occur:—

"It was but a few years ago that the Messrs. Atkinson first drew attention to their idea that coal-dust was a dangerous element in mines where blasting operations were carried on . . ."

"After Messrs. Atkinson first drew attention to the subject, Prof. Galloway took it up and made some rough experiments by placing gunpowder cartridges in heaps of coal-dust and firing them in the dark."

Although these statements were obviously uttered in ignorance of the nature of my experiments, they raise a distinct and palpable issue as to priority.

The facts are as follows:—

My first experiments with coal-dust were made on July 3, 1875. I then discovered that a mixture of air and fire-damp, which is not inflammable at ordinary pressure and temperature, on account of the smallness of the proportion of fire-damp present in it, becomes inflammable when coal-dust is added to it, and can be ignited by means of a comparatively small flame.

On December 22, 1875, I gave evidence in the capacity of Assistant Inspector of Mines at the Coroner's inquest on Llan Colliery Explosion (South Wales District), when I attributed that explosion principally to the influence of coal-dust. My evidence was discountenanced by the Chief Inspector of Mines for the district, and was not embodied in the Reports of the Inspectors of Mines, but it was reported *verbatim* in the two local newspapers (*Western Mail* and *South Wales Daily News*) of December 23, 1875.

On March 2, 1876, I read my first paper, entitled "On the Influence of Coal-dust in Colliery Explosions," before the Royal Society. In that paper I announced the coal-dust theory.

In 1878 I published a large number of articles in *Iron*, under the title of "Coal-dust Explosions." In these articles, amongst many other things, I quoted and commented upon what Faraday and Lyell had written about coal-dust upwards of twenty years previously, and I gave complete translations of the papers that had been published in France, having a bearing upon the subject.

Besides contributing a number of other articles and papers on the same subject to various societies and periodicals, I read altogether five papers "On the Influence of Coal-dust in Colliery Explosions" before the Royal Society, viz.: March 2, 1876, already referred to; February 27, 1879; May 30, 1881;

December 29, 1881; May 8, 1884; and one on "A Coal-dust Explosion," February 17, 1887.

During the ten years ending in 1885, I was engaged from time to time in carrying out experiments with coal-dust: first, with apparatus provided by the Glamorgan Coal Company, Limited, and erected at their Llwynypia Colliery; secondly, with apparatus purchased by means of Government grants obtained through the Royal Society; and, thirdly, with apparatus belonging to the Royal Commission on Accidents in Mines.

Before the accounts of my earlier investigations, and the conclusions founded upon them had appeared, the Inspectors of Mines and other mining experts were practically unanimous in attributing the cause of every great colliery explosion to the sudden outburst of a large volume of fire-damp which was supposed to have flooded the workings, become mixed with the air, and, on being ignited in one way or another, produced the various phenomena subsequently observed. This explanation was accepted everywhere as the only one possible; it was recorded in the official reports of the Inspectors of Mines, and they, as well as the experts of that generation, were irretrievably committed to it.

There was not, figuratively speaking, a ripple of dissent from this mode of explanation upon the placid surface of mining opinion at the moment the coal-dust theory was launched upon it.

At first the new theory was ignored; then it was scouted; then it was subjected to scathing criticism; then it was taken up in a tentative manner by some of the younger and bolder men: and, lastly, when it was found to be making serious headway, one of the more adventurous spirits suddenly discovered that it was not new after all, for had not Faraday and Lyell and certain French engineers been its real authors?

Following my lead, first a joint paper, by Messrs. Hall and Clark, was contributed to the North of England Institute, in May 1876, then another by Messrs. Marrecco and Morrison, in 1878, all of whom, with the exception of Mr. Clark, had previously corresponded with me on the subject of explosions; finally, in the year 1879, after the publication of my articles on "Coal-dust Explosions" in *Iron*, and during the next few years afterwards, a very great army of investigators, headed by Government Commissions in England, France, Prussia, Austria and Saxony, and including the Messrs. Atkinson, entered the field.

Some of these investigators contented themselves with criticism pure and simple; others, of whom many had neither aptitude nor training for the work, made experiments with small and imperfect apparatus, and, as a consequence, obtained only negative results; still others were carried away by the side issues; and only a few, such as the Prussian and Austrian Commissions, and Messrs. Hall and Atkinson, H.M. Inspectors of Mines, did really good and substantial work of an enduring kind.

The facts and conclusions recorded in my earlier papers were freely drawn upon: by some they were generously acknowledged; by others they were first denounced and then assimilated; by others they were adopted without acknowledgment; while some of my experiments, and notably my investigations into the nature of the Fire-damp Cap (*Proc. Roy. Soc.*, March 2, 1876), were repeated with some variations and described as if they were original.

A flood of literature was now poured upon the mining world from every side, embodying opinions of the most conflicting and mystifying character, such as—a mixture of coal-dust and air may take fire but it cannot explode; coal-dust can only carry flame from one accumulation of fire-damp to another; a coal-dust flame cannot extend throughout the workings of a mine in the entire absence of fire-damp; a small proportion of fire-damp must always be present in the air when an explosion takes place; some kinds of coal-dust are more inflammable than others—and so on, so that amid the din and hurlyburly of the strife the main question of how to put an end to great explosions was almost lost sight of.

But the scene of each successive explosion when viewed under the new light served gradually to dispel the illusions which had fascinated the majority of the investigators for years; and thus it has come to pass that the new generation of Inspectors of Mines, and those who have been associated with them in investigating the phenomena of explosions, have become convinced, I believe almost to a man, of the soundness of the coal-dust theory; and that the struggle of contending factions, which was at its height ten or twelve years ago, has gradually subsided, leaving us face to face with a work which still remains to be done, namely, to render the occurrence of a great colliery explosion impossible in the future.

Into the consideration of that problem I do not propose to enter on the present occasion, as I have lately done so in considerable detail in the pages of the *Daily Chronicle* of June 24 of the present year.

W. GALLOWAY.

Cardiff, July 17.

THE AUGUST METEOR SHOWER, 1896.

THE moon being absent from the nocturnal sky during the recent return of the Perseids, encouraged the hope that the shower would be somewhat brilliant; but the weather is an element of great importance in such observations, and it was by no means favourable during the late display. In the south of England several nights were partly clear near the important time, and on August 10 the firmament at Bristol was almost free from dark cloud; but the sky was hazy and the stars dim, so that only the brighter meteors were observed.

On August 6, during an hour's watch before 10h. 50m., I counted twelve meteors, of which seven were Perseids, with a radiant at $42° + 56°$. The shower was evidently pretty active, and the meteors fairly bright, but clouds overspread the sky before 11h., and prevented further observation.

On August 7, in an hour's watch preceding 11h., nine meteors were seen, including about six Perseids, but clouds were very prevalent during the whole time, and effectually obliterated the stars at a later period of the night.

On August 10 the weather was fine, but the atmosphere was not transparent enough to be considered favourable for meteoric work. Haze was spread over the sky, and the fainter stars were obscured. Near the horizon nothing could be discerned. I began watching for meteors at about 9h. 50m. and continued until 14h. 15m. During this interval of 4h. 25m. I saw ninety-eight shooting-stars, of which sixty-nine were Perseids, and twenty-nine belonged to the minor, contemporary showers of the period. I registered the apparent paths of a considerable number of the meteors seen, and while engaged in doing this, must have missed many others which appeared while my attention was diverted from the sky. It is probable that fully one hundred and fifty meteors would have been counted by an observer watching the sky uninterruptedly during the period mentioned. Nearly all the Perseids left streaks, but the meteors generally were not very bright. The radiant point was tolerably well defined, but it was certainly not so definitely marked as I have sometimes seen it. I determined it at different times of the night as follows:—

h. m. h. m.		° °
9 50 to 11 0	... ...	43 + 57
11 0 to 11 30	... ...	44 + 57
11 30 to 13 0	... ...	46 + 57
13 0 to 13 45	... ...	45 + 59
13 45 to 14 15	. ...	46 + 57

The mean of the five positions being at $45° + 57°$, which coincides with the usual place of the radiant on August 10.

On August 11 the heavens were overcast, but on August 12 a beautifully clear sky enabled me to resume observations. I saw fourteen meteors in about an hour and a quarter before 11h. 15m., and of these seven belonged to the Perseid shower. The radiant was at $46° + 57°$, but it was imperfectly defined.

On August 14 the firmament was again clear, and I saw nine meteors in three-quarters of an hour before

11h. 10m., of which one only was a Perseid. The shower had evidently become nearly exhausted.

The following conspicuous meteors were recorded on the several nights of observation, and I give their paths in the hope that they have been observed elsewhere.

1896.	Time.	Mag.	Path From	Path To	Length.	Radiant.
			° °	° °	°	° °
Aug. 4	9 46	1	343 +31	335 +10	27	42+56
6	10 6	2	340 +31	337 +58	27	342−12
6	10 6	1	343 +32	328 +10	26	42+56
10	9 54	1	103 +86	202 +79	13	43+57
10	10 39	2	27 +48	355 +39	24	60+48
10	11 24	1	15 +47	9 +43	6	44+57
10	11 39	♃	66 +84	210 +81	15	46+57
10	12 6	2	42 +45	44 +39½	6	28+72
10	12 10	2	44½+35	53½+31½	8	23+40
10	12 15	> 1	28 +24	24 + 4	20	46+57
10	12 19	2	60½+31½	66 +26½	7	47+42
10	12 46	1	8 +12½	1 − 3	17	46+57
10	13 8	♃.	633 +63	25 +66	5	45+59
10	13 19	1	23½+20	20½+12½	8	45+59
10	13 22	1	359 +69½	334 +68	9½	45+59
10	14 14	> 1	57 +76	225 +77	27	51+31
12	9 24	♃	195 +24	199 + 9	15	46+57
12	10 41	2	26 +43½	30 +38	6	331+70
14	9 24	1	265 +22	240½+19	23	356+ 5

On the whole, I regard the display as one much inferior to many observed in past years. Both as regards the number and brilliancy of the meteors there was nothing striking to record. Had the sky proved clearer on August 10, many small meteors would have been visible, which, under the conditions prevailing, were enabled to escape detection; but making every allowance for this, there is no doubt the shower was not a conspicuous one.

As to the displacement of the radiant, which takes place on successive nights, this was indicated from my results on August 6, which gave $42° + 56°$ for the position, while on August 10 it was $45° + 57°$, and on August 12, $46° + 57°$. But my observations this year have not been sufficiently extensive for the full and proper re-investigation of this feature, nor is it required, for no good end is served by the frequent re-observation of a fact already well determined.

The usual minor showers were visible; indeed, there appears to be very little doubt that the great majority of meteor radiants are manifested annually without any great change in their visible strength. Certain showers vary more than others, but many of the differences observed are due to the alteration in the conditions under which they are presented from year to year. In 1893 there was a strong shower of Cygnids observed contemporaneously with the Perseids, but the former was but slightly seen this year, for I recorded only two of its meteors. I registered meteors from radiants at $31° + 20°$, $28° + 72°$, $60° + 48°$, $331° + 70°$, $356° + 5°$, which have been noticed in preceding years, and are among the best assured positions of the August epoch. Feeble showers of this character are extremely numerous, and require long watches before an observer can satisfactorily determine their radiants. Some of them fall so near together that they cannot be disassociated unless the observations are very numerous and accurate.

I observed no fireballs during the recent return of Perseids; but Mr. Blakeley, of Dewsbury, reports that he saw meteors as brilliant as Venus on August 10, at 11.40 and 12.16, both Perseids.

The Rev. S. J. Johnson, of Bridport, writes me that he observed a good many bright meteors this year. One of the finest appeared on August 10, 9h. 50m., travelling from ϵ Cassiopeiæ to a point 7° west of β in the same constellation. Two second magnitude meteors were seen within fifteen seconds of each other at about 10h. 6½m. on the same night, which were also observed at Bristol. Their heights at beginning were 64 and 65 miles, and at ending 46 and 52 miles respectively. They were both Perseids.

Mr. Blakeley, of Dewsbury, saw about thirty-five Perseids between 11h. and 12h. 30m. on August 10, and the paths seemed to give a sharply-defined radiant at the usual maximum position.

Mr. S. H. R. Salmon, of Croydon, saw, on August 10, 20 meteors (15 Perseids) between 9h. 10m. and 10h., and 18 meteors (16 Perseids) between 10h. 10m. and 11h. The sky was perfectly clear.

Mr. D. Booth, of Leeds, on August 11, saw eighteen meteors in the forty-five minutes from 10h. to 10h. 45m., and found the Perseid radiant at $47\frac{1}{2}° + 58\frac{1}{2}°$.

W. F. DENNING.

THE LIVERPOOL MEETING OF THE BRITISH ASSOCIATION.

III.

IT is possible now to forecast to some considerable extent the work of the various Sections from the information already received from presidents, recorders, and authors.

In Section A (Physics), Prof. J. J. Thomson's opening address will deal, we believe, with (1) the teaching of physics; (2) the kathode and Röntgen rays; (3) the passage of electricity through a gas; and (4) the movement of the ether. Friday will be devoted in this Section chiefly to phenomena connected with the Röntgen rays; and on Saturday the Section will divide into the two departments of mathematical physics and meteorology.

In Section B (Chemistry) the address of the President (Dr. Ludwig Mond) will deal with the development of the industrial manufacture of chlorine. Technical papers will probably occupy a large portion of Friday's sitting, including a report, by Prof. Bedson, on the composition of coal. On Monday, Prof. Ramsay will read a paper on helium, and there will be a number of other communications on helium and argon. On the same day, a paper will be read on the synthesis of the elements. It is hoped that this will lead to a discussion, to which several have promised to contribute. Other matters of interest will be an exhibition of photographs of explosions in various gaseous mixtures, by Prof. Dixon, and the report of the Committee on science teaching in elementary schools, which will be followed by a paper on science teaching in girls' schools, from Miss Walters.

It is hoped that the numerous chemical works in the neighbourhood may prove attractive to the members of the Section, and arrangements are being made for members of the Section to visit several of the most interesting works on special afternoons.

Mr. Marr's address to Section C (Geology) will be devoted to recent advance in stratigraphical geology. He will notice at some length the imperfection of the geological record, especially in the earliest times. He will advocate the continuance of that work in detail which has been the cause of our best discoveries in the past. Doubt will be thrown upon the advantage of too rigid an adherence to uniformitarianism. Lastly, he will discuss the advantage of geology as an instrument of education. In the work of the Section, more prominence than usual will be given to the reports of the research committees, several of which are likely to lead to considerable discussion. The excavations at Hoxne have been successful in proving the relation of Palæolithic man to the glacial epoch, besides yielding new evidence as to alternations

of climate during the Pleistocene period. Sir William Dawson will deal with pre-Cambrian fossils, and a number of papers are promised on local geology.

In Section D (Zoology), the President (Prof. Poulton) will take as his subject a naturalist's contribution to the discussion on the age of the earth. His object is to show that the appearance in time, and succession, of the various groups of animals in every way supports evolution, but an evolution which took its rise in a very much more distant past than the Cambrian or Laurentian. The general result will be to strongly support the geologists against certain of the physicists. The other arrangements in Section D are: On Friday forenoon a debate on Neo-Lamarckian theories, probably introduced by Prof. Lloyd Morgan; and in the afternoon, a report and discussion on the fauna and flora of the Irish Sea; on Saturday, a report on the migration of birds, and then a dredging and trawling expedition in Liverpool Bay; on Monday forenoon, a debate on the ancestry of vertebrates, introduced by Dr. Gaskell; on Tuesday forenoon, a joint meeting with the Botanical Section for a discussion on the cell theory; while Wednesday and the remaining afternoons will be occupied by papers which have been announced by Prof. Minot and Messrs. Macbride, Newstead, Benham, Traquair, Hartog, and others. Sir William Dawson brings some fresh evidence in regard to *Eozoon*, and Dr. Traquair will give the latest information in regard to *Palæospondylus*, illustrated by recently acquired specimens and an enlarged model.

In Section E (Geography), the address by the President (Major L. Darwin) will deal largely with African railways. Papers have been promised by a number of travellers and others, including Mr. Moir (climate of Nyassaland), Mr. Heawood (African geography), Rev. C. H. Robinson (Hausaland), Mr. Fletcher (journey in Tibet, with Mr. Littledale), Mr. J. Coles (photographic surveying), Mr. Vaughan Cornish (sand-dunes), Mr. H. N. Dixon (marine research in North Atlantic), Mr. E. A. Fitzgerald (the New Zealand Alps), Mr. A. W. Andrews (geography and history in schools), Mr. A. J. Herbertson (geographical teaching), Prof. J. Milne (Japan and its earthquakes), Dr. H. R. Mill (local geography of England), Mr. Harry Lake (the Gambia and Senegal). It is hoped that papers will also be offered by Count Pfeil, Mr. Lewin, Mr. Howard, Colonel Woodthorpe, the Archduke Ludwig Salvator, Captain Vandeleur, Colonel Trotter, Mr. Hull, and Mr. Fowler. There will also be reports on African climatology and on geographical education.

In Section G (Mechanical Science), the President's address, on Thursday morning, will be followed by a report of the Committee on Tides, and after that comes a paper by Mr. G. F. Lyster on the Dock development of Liverpool. There will be other papers on local engineering works. the Atlantic steamships, the overhead railway, and the Liverpool waterworks. Papers are also announced by Mr. Wolf Barry on the Tower bridge, by Prof. Mengarini on the electric light and tramway systems of Rome, and by Mr. A. R. Sennett on horseless carriages—a number of which, it is expected, will be shown in operation.

In Section H (Anthropology), following the precedent which proved so successful at Ipswich last year, it is proposed to group the proceedings of the Section round a limited number of large questions which seem more particularly ripe for discussion at this time. The fact that the President, Mr. A. J. Evans, the Keeper of the Ashmolean Museum at Oxford, has taken a leading part in recent exploration and discovery among the remains of early civilisation in the Levant, and that a public lecture by Prof. Flinders Petrie, last year's Sectional President, is announced on a kindred subject, suggested the early history of mankind in the Mediterranean as an appropriate subject for discussion.

The President's address, which will be delivered late in the morning of Thursday, may be expected to deal, in part at least, with this department of anthropology, and will be followed by lantern demonstrations of recent Palæolithic discoveries in North-east Africa and elsewhere. Friday will be devoted to physical anthropology, and the opportunity will be taken of commemorating the centenary of the birth of Dr. Retzius, the celebrated Swedish anthropologist, whose son, himself a distinguished observer, has signified his intention of probably being present. Dr. Dubois will discuss *Pithecanthropus*, and Dr. Brinton and Dr. Sergi the physical aspect of Mediterranean and, especially, of North African races. Dr. Topinard is expected to be present, and a communication is promised on the pygmies of Central Africa. Saturday is assigned to reports and discussions on the collection and registration of ethnographic data, and a resolution in favour of an Imperial Bureau of Ethnology will be brought forward by Mr. C. H. Read, of the British Museum. Folk-lore and descriptive anthropology will also be represented on this day. Monday opens with papers on the early distribution of copper and of iron in Europe and the Mediterranean; followed by a general discussion of the modes of the transference of culture, and illustrated by an exhibition of the early ornament of North-west Europe. On Tuesday, a general discussion of early Mediterranean civilisation has been arranged. Communications are expected from the President, Dr. Montelius, Mr. Salomon Reinach, Dr. Naue, Dr. Stolpe, Prof. Ridgway, and others. On Wednesday, Prof. Flinders Petrie's proposal of a national ethnographic storehouse comes up for discussion, and a number of separate communications will be presented. It is hoped that it may be possible to announce somewhat in detail the probable course of each day's discussion during the meeting.

In Section I, the President (Dr. Gaskell) will give his address and a paper on the origin of Vertebrates on Monday morning, and after that a joint discussion with the Zoological Section will take place. Other discussions have been arranged within the Physiological Section: (1) on the organisation and correlation of bacteriological work, to be opened by Dr. Sims Woodhead; and (2) on the presence, and effect, of bacteria in various food matters, by Dr. Kanthack. Profs. Boyce and Herdman will bring forward a report on oysters and typhoid; and various other papers are announced dealing with excitability in muscle and nerve, metabolism, gas exchange, &c.

In Section K, the President (Dr. D. H. Scott) will deal in his address with the present position of morphological botany, discussing modern work bearing on the origin and affinities of the main groups of plants with reference to fossil as well as to recent forms. The chief features, after the address, will be (1) an afternoon lecture on the geographical distribution of plants, by Mr. W. Thiselton-Dyer, Director of the Royal Gardens, Kew; (2) the joint discussion with Section D on cell and nuclear structures, to be opened by Prof. Farmer; and (3) a discussion on the ascent of sap, to be opened by Mr. Francis Darwin of Cambridge.

We understand that Prof. Flinders Petrie's aim in his evening discourse, entitled "Man before Writing," is to bring forward the character of civilisation in different countries just before the introduction of writing, to show what man is and does before the great change produced by unalterable record and transmissible message: also to point to the methods of research where no written record remains. This period covers what is now the main field of interest in European history, and also the culture of the new race in Egypt. Dr. Francis Elgar's lecture will be on "safety in ships," and Prof. Fleming's lecture to the operatives will be on "the earth a great magnet."

W. A. Herdman.

THE TOTAL ECLIPSE OF THE SUN.[1]

II.

KIÖ ISLAND, *August* 8.

A LOVELY morning. The sun remained unclouded till long after eclipse time, giving thereby an additional proof of the advantage to us of the short nights. There is no time either for any considerable reduction of temperature or for the accumulation of any great amount of moisture in the air; hence unclouded sunrises, and the sun strikes hot soon after rising.

The beautiful harbour in which the *Volage* is lying looks its best in early morning, as the face of the nearly vertical cliff, which swarms with bird life, lies nearly west and south, facing eastwards.

I am glad to say that the last adjustments have been made, the last demonstrations given; numerous rehearsals have landed us in the perfection of drill; the parties all know their stations, and all necessary forms

FIG. 5.—The *Volage* at anchor.

have been written out. We are going then to-day to "stand easy," and take some rest in preparation for the fateful to-morrow.

I take advantage of the pause to continue my notes. I confess I am keenly interested in our now tremendous eclipse party. I will first of all, then, deal with its progress, and especially with the final arrangements made for the larger instruments.

The *personnel* of each fixed instrument is as follows. Mr. Fowler has charge of the 6-inch prismatic camera, and he receives the following assistance.

As timekeeper Sub-Lieut. Beal offered his services, and his duty is to give Mr. Fowler warning some seconds before the commencement of totality, and to record the times of exposure of the fifty plates intended to be used. Roberts, an A.B., acts as exposer, taking off the cap from the prism at given signals. To economise the greatest amount of time, two marines stand to Mr. Fowler's right and left, to hand and receive the slides as they are inserted in and drawn out of the camera. The exposures to be made are generally very short, in fact they are all snap-shots with the exception of only two, one of them extending to half a minute.

The plate-holders are ten in number; each is capable of holding five plates, which are exposed by slipping them in turn into the focal image; this operation is controlled by a catch. The hut in which this instrument is housed is one brought out from home; the framework is covered with waterproof canvas so arranged that the roof can be removed at any time for observation. A dark room for photographic work is also attached.

The instrument under the charge of Dr. W. Lockyer is also a prismatic camera, but of 9 inches aperture, and rather differently mounted. The tube carrying the camera, prism and lens is fixed horizontally, and the light is thrown on to the prism by means of a siderostat. The work intended to be done is to obtain ten photographs in all; two snap-shots, seven with different times of exposure, the greatest amounting to thirty seconds, and lastly, a "dropping" plate. This last-named is intended to be exposed as near as possible ten seconds before the end of totality, and carried through until fifteen seconds after, the plate being moved slowly in the direction at right angles to the length of the spectrum. The object of this motion is to obtain an unbroken record of the changes in the spectrum during this interval of time.

As timekeeper for this instrument Midshipman Bruce has been selected, his duty being to keep Dr. W. Lockyer informed of the time a few seconds previous to totality, and also to note the times and lengths of the exposures made during totality. One of the ship's carpenters, Sullivan, operates with the cap in front of the prism, acting on instructions given to him by the observer. Two bluejackets are also employed in handing and replacing the dark slides as they are required.

The whole work of using the integrating spectroscope is left to members of the ship's company. Lieut. Martin has been selected as director, and he has as his assistants Midshipman Woodbridge as "exposer," Midshipman Brendon as timekeeper, and Midshipman Silvertop to keep the sun's image on a small screen for the purpose of correct orientation.

The instrument is set up on a board inclined at the angle representing the altitude of the sun at the time of eclipse, and movable in azimuth by means of a milled-head-driving screw turned by hand. By this means the collimator can be directly pointed towards the sun, which does away with the necessity of using a second siderostat, and this is all the more important because we have not a

[1] Continued from page 400.

second siderostat. The intention is to make three exposures with this instrument.

The whole apparatus is housed in a tent made by the carpenter out of ship's material, spare spars and a sail. The peculiar appearance of the hut has resulted in its being named by the sailors Porcupine Cottage. The hut for the 6-inch, which adjoins it, is called the Town Hall.

With regard to the other branches of work, in some of which the numbers assisting are large, the senior volunteer in each has been made responsible for the preparation and subsequent signing of forms, and representative in general of the party. The Chaplain, the Rev. E. J. Vaughan, whose interest has been unflagging throughout, has been good enough to act as intermediary between these representatives and myself, so that the closest touch has been kept. It was thought desirable that in addition to acting on the general instructions, each party should know the special points on which information is desired. A request for detailed answers to certain questions has been therefore placed in the hands of the head of each section.

I have said that this morning was lovely; yesterday — the 7th — was not by any means a pleasant and bright day, but the rain managed to keep away and allow work to be carried on in the camp, in which the preparation and the rehearsals have been vigorously continued. The first boat leaves the ship at about five each morning, so as to secure drill at eclipse time, and from this time onwards there is a continual passage of boats from ship to camp and back again, as the various observers are released from their work, which goes on incessantly, not only on board among the guns and masts, but in the fjord, in the shape of firing and boat parties, the firing being strongly objected to by the inhabitants of the "loomery," which is hard by.

The birds, which in our stay we have become acquainted with, are of several kinds. Foremost among these is the white seagull, which has its home on the crags and ledges of the cliff to the west of the *Volage*. These birds literally swarm here, but apparently seem to be divided into distinct societies; indeed, on the cliff there are three or four separate "loomeries," and the birds in each of them always keep together and seldom, if ever, intermix with those in others. At apparently fixed times they fly down from their ledges and form a teeming, hurrying, clamorous throng, eddying in front of the face of the cliff. The young birds at the time are just beginning to fly, so the noise is perhaps greater than usual. After we had been here a few days they all became very tame, and swam around the ship. On Starvation Island several young ones were found; these could be easily located by paying attention to the utterances of the parent birds flying overhead, which became louder and louder the nearer the right spot was approached.

The young birds were found always in small pools between the rocks, generally lying under small bushes of grass overhanging them. The bluejackets, when ashore, caught many in this way, and it was amusing to see these birds walking about the forecastle as if owners of all they surveyed. An amusing incident occured on the evening the *Volage* arrived from Vadsö. Lieut. Martin and Sub-Lieut. Beal, on going on board the sailing cutter, found a dead gull in the bottom of the boat; on further examination, no less than 20 to 25 more were found stowed away in the stern. On making inquiries of the bluejackets as to their presence, they replied that they had collected them for supper in case the ship did not arrive that night, as provisions were rather short. The ship, however, did arrive, so that fried gull was not indulged in.

The shag, or green cormorant, abounds also in great numbers. These birds are far from beautiful, and were disliked by everybody. Many of them were too fat to fly properly, and when disturbed they managed to make themselves scarce by flopping over the surface of the water. The reverse was the case with the prettily marked oyster-catchers; these were always watched with interest, and there were five which greeted the party daily as it landed on Kiö Island. These birds are noted for being very self-possessed, cautious, and deliberate; and any event out of the ordinary arouses their curiosity, and incites them to make closer examination. Of the other birds seen, some were quick-moving sea-swallows, and a few ducks skimming occasionally along the fjord.

Fig. 6.—The Siderostat and the 9-inch Hut.

On our island, Kiö, there are several Lapps who continually watch our movements. In the small bay on the western shore there is one small hut in which about five, including one woman, live; while generally some of the others encamp in small curiously-looking huts near by; or either sleep in their boats or on skins ashore. In the bay to our south-east, on the other side of the fjord, there is quite a large Lapp encampment, and it is from this that most of our visitors come. The accompanying group shows many of these. This photograph was taken instantaneously, and without any preparation as regards grouping, and shows them as they sat watching us erecting the huts and instruments. At this time

of the year they are generally occupied in fishing, and they sometimes bring up very fine selections of fish to our camp, which are generally bought by the steward for the ship's mess. The peat also on the island had been cut and stacked, so that this also formed at an earlier period of the year part of their daily work.

We are quite out of the world here, and till yesterday had no information as to what the other parties were doing at Vadsö. We knew that the remaining ships of the Training Squadron had arrived on Wednesday, and the booming of salutes from time to time informed us that other men-of-war had arrived. We could get no information concerning the astronomical parties, and no observer could be spared to make inquiries.

But late on Tuesday, when we had finished sketching drill, and were experiencing our only fog, a syren and the quick reply of the ship's bell told us that some vessel was approaching. Shortly afterwards we made out one of the small steamboats which ply from Vadsö to the fjords on the south side; she subsequently came alongside. We saw that Dr. Common and Sir R. Ball were on board, and I hailed them from the poop. Captain King Hall hospitably invited them on board, but the invitation was declined owing to the weather conditions, which were not improving, and the lateness of the hour. They had still to run twelve miles to reach Vadsö.

Captain King Hall invited Dr. Common, Sir R. Ball, and Mr. Downing to come over from Vadsö yesterday to lunch and see our camp. Dr. Common was too busy in setting up and adjusting his instruments, but Sir Robert Ball and a small party paid the ship a visit. We had previously arranged that the final dress rehearsals should take place in the afternoon, so our visitors were just in time to see the drill gone through. All timekeepers, chronometer, stop-watches, and deck-watches were ready. Each man was at his appointed post; the sketchers stood to the west of the camp on the higher ground; the disc observers were blindfolded and in their places, while each of the other instruments was attended by its full staff. These rehearsals must appear very curious to those unacquainted with eclipse work, and certainly our visitors saw the very perfection of drill. The routine gone through was exactly the same as if the eclipse was taking place, with the exception that no plates were actually exposed. After these general rehearsals the observers at each special instrument were put through their facings. Our visitors seemed to be rather astonished at the great amount of work that will be done if the weather only proves favourable to-morrow.

We gathered from Sir R. Ball that all the arrangements at Vadsö were nearly complete, and that Dr. Copeland's 40-foot tube was already in position.

The time arrangements have to be somewhat complicated, for the reason that it is desirable to begin the exposures with the prismatic cameras ten seconds before totality. We have then, if possible, to make a correction should the *Nautical Almanac* times be slightly out. The Admiralty authorities were good enough to put on board at Portsmouth a first-rate chronometer for our special use, and Lieut. Martin and Sub-Lieut. Beal have been unremitting in their endeavours, by taking sights and noting rates, to give us G.M.T. within a small fraction of a second.

FIG. 7.—The Integrating Spectroscopic Camera.

Before totality we have two chances of checking the *Nautical Almanac* times; by observing the first contact spectroscopically, and, failing this and more doubtfully, by observing the crescent when it covers an arc of 180°; this, it has been calculated, should occur 7m. 10s. before totality. It has been arranged that after the first contact the true G.M.T. will be called out from time to time as required, and also each minute before totality, corrected, if necessary, in the way I have already stated. In this way the special timekeepers of the prismatic cameras will be able to begin their work at the right moment before the general signal for totality, "Go," is given.

I am sorry to say that the eclipse-clock has broken down; the ship's armourer has vastly improved its going, but it has received some damage, so that I cannot rely on it. It is not good for a clock to be used only once in five years or so! So we fall back on stop-watches; and here I must state my obligations to Mr. Tripplin for the loan of a fine chronograph, which makes our stock complete, and enables us to feel certain that at one station or another the exact duration of totality will be caught.

My intention is before totality, in case we miss the first contact, to set one of the stop-watches going when the crescent covers as near as may be 180° of arc; this will give us time to correct the *Nautical Almanac* if necessary. Another will be handed to our two excellent timekeepers to replace the eclipse clock.

Two things have been strongly impressed upon me in my eclipse experience. The first is always to arrange the work so that everybody can have 30 seconds in which to observe the phenomena of the eclipse with the naked eye; the second, to take out no case which weighs more than 50 or 60 lb.

The importance of the first was forced upon me in 1871, when Captain Bailey, who travelled 400 miles to our camp to help us, and volunteered to act as timekeeper, turned his back resolutely on the eclipse and saw absolutely nothing of it, because in the preliminary drills he found he had a difficulty in picking up the time again when once he looked away from the face of his chronometer.

This time then we have a relay of timekeepers, one replacing the other at "60 seconds more"; this signal is given by both. The one who gives the time has his back to the sun, the other will see what he can. At my signal, "Go," depending upon the final disappearance of the photosphere as seen in a $3\frac{3}{4}$ with neutral tinted glass, the timekeeper first on duty is to sing out "105 seconds" and give the time every 5 seconds, "100 seconds," "95 seconds more," and so on.

The question of lamps during the eclipse is settled in the following way. If the sky be quite clear, some will certainly be wanted for the timekeepers in the huts, and for reading the fine graduations of the delicate chemical thermometers which I have brought with me. But if the sky be not clear, then others may be wanted too. So Captain King Hall has arranged to have ten lamps, each in charge of a bluejacket, in reserve, in the middle of the camp, so that anybody who wants one has only to say so to be immediately supplied.

A guard of five marines has remained permanently at the camp during our stay. They are generally dressed in most arctic-looking costumes known as "lammy suits." These are nothing more than a pair of trousers and jacket (with a hood), made out of ship's blankets, worn over the ordinary dress; they were invented, I believe, by the sailors when they made a long stay at Spitzbergen. They seem to be grand clothes for a camp, and in fact one of the marines seems to be seldom out of his—he appears to revel in the warmth it gives. Besides acting as guard to the camp, the marines are useful in many other respects; for instance, in addition to signalling for us, they are very good cooks, and all our cocoa, soups, meat, &c., brought from the ship, only needs to be handed over to them to be served up in our tent in a very appetising condition.

Fig. 8.—Our Lapp Visitors.

Since the eclipse begins so early on the morrow, arrangements have been made that a few of us should sleep in the camp to-night, and thus come under their special care; the ship's company will come over in the morning.

J. Norman Lockyer.

(*To be continued.*)

PROFESSOR A. H. GREEN, F.R.S.

Geological science has sustained a very serious loss in the death of Alexander Henry Green, Professor of Geology in the University of Oxford. He was born at Maidstone on October 10, 1832, and after receiving his early education at the grammar school at Ashby-de-la-Zouch, he entered Gonville and Caius College, Cambridge. There he gained the place of sixth wrangler in 1855, and was elected a fellow of his college. Although mathematics had gained for him his high position in the University examination, yet geology had taken some hold of him. His interest in the subject had been awakened in Leicestershire, and the eloquent teachings of Sedgwick had further attracted him to the science.

In 1861 he obtained the appointment of Assistant Geologist on the Geological Survey of Great Britain, and was engaged for some years in mapping portions of the midland counties, near Aylesbury, Buckingham, and to the east of Banbury. Three years later his memoir on the geology of the country around Banbury was published; and although since then some modifications have been made in the grouping of the oolites, his careful statement of facts rendered the work of permanent value. Leaving these regions of lias and oolites and glacial drifts, he was transferred to the carboniferous districts of Derbyshire and South Yorkshire. Here he laboured for a number of years, practically superintending the survey of the great coal-field, and training several junior geologists to assist in the work. In the end he produced, with the aid of his colleagues, the large and exhaustive memoir on the Yorkshire coal-field, published by the Geological Survey. In 1875 he resigned his post on this survey on being appointed Professor of Geology in the Yorkshire College at Leeds. Ultimately he became

also Professor of Mathematics at the same college. Although by no means a voluminous writer, he contributed occasional papers to the Geological Society and to the *Geological Magazine* on the carboniferous rocks of the north of England, on sub-aërial denudation, on the geology of Donegal, the Malvern Hills, &c. His practical knowledge of geology, his clear head, and sound judgment rendered his advice on matters of engineering geology of great service. Consequently he was engaged here and there in many important undertakings, more especially in reference to coal-mining, water-supply, &c. This work, perhaps unfortunately, was needful, for it exhausted those energies that might have been more advantageously directed to the advancement of knowledge. Professorships of geology are not, however, lavishly endowed. Visiting portions of South Africa in the course of practical work, he was able to obtain a considerable insight into the geology, and brought his results before the Geological Society. Not the least important of his labours was his manual of Physical Geology, admittedly the best English work on this branch of the science, and one which reached a third edition in 1882. The companion volume on Stratigraphical Geology was never completed, and indeed other publications perhaps rendered it unnecessary.

After the resignation of Prof. Prestwich in 1888, he was chosen to succeed him in the chair of Geology in the University of Oxford. Here he found abundance of work to do in the arrangement of the geological museum, in his lectures and class excursions. A large task, indeed, still remains to be done in the examination of many treasured specimens that have never yet been exhibited. Prof. Green took great interest in this work, and in the acquisition of new specimens. Only recently he spent some time in selecting a series of fossils from the valuable collection of the late Thomas Beesley, of Banbury, which had been presented to the Oxford Museum by Mrs. Beesley.

Prof. Green was elected a Fellow of the Royal Society in 1886, and he served on the Council during the years 1894–95. For many years he gave lectures on geology at the Military School at Chatham; he was an examiner in geology for the University of London; and had been President of the Geological Section of the British Association at Leeds in 1890.

Early in August he was afflicted with a stroke of paralysis, and a second attack terminated his busy and useful life on the 19th of the month. Eminently genial and kind-hearted, he will long be missed by his many friends. H. B. W.

NOTES.

AT the Leyden International Zoological Congress, held last year, it was decided that the next meeting of the kind should take place in England, in September 1898, and that Sir William Flower, Director of the British Museum (Natural History), should be its President. We now learn, through the *Times*, that it has been determined that the 1898 Congress, the fourth of the series, shall meet at Cambridge, under the auspices of the University, simultaneously with the International Physiological Congress, which has arranged to go there in that year. London and Edinburgh were named as places of meeting in connection with the Zoological Congress, but it was felt that there were certain advantages in holding an international meeting of this character in a University town within easy distance of London, rather than in London itself. The organising and reception Committee consists of Prof. Alfred Newton, President; Mr. Adam Sedgwick, Vice-President; Messrs. J. W. Clarke and Sydney J. Hickson, Treasurers; and Messrs. S. F. Harmer and Arthur E. Shipley, Secretaries. With reference to the two prizes which will be awarded at the Congress for the best zoological papers, the Paris members of the permanent Committee suggest that the subject for the Tsar Alexander III. prize, which will be given for the first time, shall be "The Study of the Ruminant Mammalia of Central Asia, from a Zoological and Geographical Standpoint"; and that for the Tsar Nicholas II. prize, which was awarded last year at Leyden for the first time, the paper shall be "An Anatomical and Zoological Monograph of a Group of Marine Invertebrates." These subjects are, however, in the nature of proposals which may be modified, since the Paris Committee will be glad to receive counter-suggestions and to learn the views of zoologists before making public the detailed programme of the prizes.

THE annual conference of the Iron and Steel Institute opened at Bilbao on Tuesday, under the presidency of Sir David Dale. Various papers were read, and in the evening a grand reception was given by the municipal authorities in honour of the Institute.

INFORMATION has been received through Reuter's agency of the finding of an extensive gold-bearing quartz reef at Cape Broyle, Newfoundland. The analysis shows nearly three ounces of gold to the ton of quartz, and over one ounce of silver. The barrels of quartz sent for analysis were taken at random.

DR. E. S. HOLDEN announces in *Science* the following gifts to the Lick Observatory:—By Miss Caroline W. Bruce, of New York City, a sum of money to procure a large comet-seeker, and to provide photometers for visual use with the thirty-six-inch equatorial; by Mr. Walter W. Law, of Scarboro'-on-Hudson, a liberal gift towards providing for the publication of the Observatory Atlas of the Moon, mentioned in the *Publications*, vol. viii. p. 187.

THE forty-first annual exhibition of the Royal Photographic Society is in course of preparation, and will be opened to the public on Monday, September 28. On Saturday, September 26, there will be a private view, followed in the evening by a conversazione, at which the President and Council will receive the fellows, members, and their friends. The judges this year in the technical section are Captain Abney and Messrs. Chapman Jones and Andrew Pringle. Exhibits must be delivered at the Society's rooms, at 12 Hanover Square, not later than the morning of September 10.

PARTICULARS of the International Horticultural Exhibition to be held in Hamburg, from May to September next, have now come to hand. The Committee proposes: (1) a Permanent Exhibition, out-of-doors and under cover, from the beginning of May 1897, to the end of September, 1897; (2) a Spring Exhibition, from May 1 until May 7, 1897; (3) a Special Exhibition of plants, flowers, and vegetables, from May 30 until June 3, 1897; (4) a Special Exhibition of plants, flowers, and shrubs, from July 2 until July 6, 1897; (5) a Special Exhibition of plants, flowers, and fruits of the season, from July 30 until August 3, 1897; (6) a general Autumn Exhibition from August 27 until September 5, 1897; (7) a general Fruit Exhibition, from September 17 until September 30, 1897.

THE seventh annual general meeting of the Federated Institution of Mining Engineers is announced to take place at Cardiff on September 15, 16, and 17. Some thirteen papers are on the agenda, and many excursions have been arranged. An invitation has been given to the Federated Institution, among others, by the Canadian Mining Institute, to hold a meeting in Montreal at about the date of the meeting of the British Association in Toronto next year; but before replying, the Secretary of the Institution is anxious to learn the names of those who may be expected to be present on the occasion.

Kief has been selected as the place of meeting of the tenth conference of Russian Naturalists and Physicians. The conference will last from August 21 to August 30, 1897. A grant of over £400 has been contributed by the University of St. Vladimar in Kief towards the expenses.

Good progress is being made by the Russian National Health Society in the matter of the Jenner Commemoration of October next. The centenary work, containing a life of Jenner and translations of all his works, as well as an historical notice of the development of vaccination in Russia and other European countries, is likely to be a volume of much interest and value. It will be illustrated by over a hundred figures, including many reproductions of Jenner's original drawings, portraits of Jenner, and views of the Berkeley neighbourhood. The Society, under whose auspices the commemoration is to take place, is already in receipt of a large number of loans and gifts for the exhibition which it is proposed to hold in connection with the celebration, and these have come from well-nigh every part of the world. England, it is said, is not too well represented by exhibits.

News comes from Russia of another medical society having received the, in that country, necessary Imperial approval of foundation. It is to be known as "The Society for Combating Infectious Diseases," and will be under the patronage of the Princess of Oldenburg. The society will resemble the Russian National Health Society, in that it will admit both lay and medical members.

According to *Science*, an observatory for terrestrial magnetism has been established in connection with the astronomical observatory at Munich, and Dr. Franz von Schwarz has been appointed director. *Science* also states that the Observatory of the School of Technology at Karlsruhe is to be removed to Heidelberg. The Director of the Observatory, Dr. Valentiner, has been made a Professor in the University of Heidelberg.

A magnetic survey of Maryland is being made by Dr. Bauer, the editor of *Terrestrial Magnetism*, under the auspices of the State Geological Survey.

The *Engineer* states that Colonel Home, C.S.I., Royal Engineers, has been engaged by the New South Wales Government as an expert to advise on the subject of water conservation.

The *British Medical Journal* learns from Amoy, China, that Dr. Yersin has been experimenting with his plague serum. Up to date he is reported to have cured more than twenty plague patients. The cures are reported to be marvellous, as many of the patients were in high fever, the buboes fully developed, and the sufferers in a comatose state. In Canton Dr. Yersin, on July 1, 1896, according to Bishop Chausse, effected a remarkable cure on a very unmistakable and severe case of plague. After showing the Amoy doctor his methods of injection, he returned to Saigon. It is stated in the newspapers in China that it takes six months to prepare the serum; that Dr. Yersin first inoculates rats and then horses, from which sources he obtains his fluid.

The subject of the Baumgartner Prize for 1899, awarded by the Vienna Academy of Science, is "the extension of our knowledge of ultra-violet rays."

The Leopolinisch-Carolinische Academie of Halle is, it is stated, about to publish Cuvier's first work, which is on the edible crabs of the French coast. It dates from the year 1788. A number of letters of Cuvier are in the possession of the Academy, and these also it is intended to publish.

The University of Moscow has been presented with a portion of the collection of butterflies of the late Prof. A. M. Butljero, and the Museum of Natural History, Berlin, has had bequeathed to it, by the late Julius Flohr, that gentleman's collection of Mexican insects.

Some one once rather unkindly said that one half of the British population was always endeavouring to shut up the other half in asylums of one kind or another. Though this remark may be a trifle exaggerated, it may be applied with some truth if societies or associations be read for asylums. The latest association which has appealed for our support is for the Harmonious Development of Faculties. The Association aims at bringing about a clearer apprehension of the co-relationships of physical, moral and intellectual faculties. Anything that contributes to the harmonious development of these is good; anything that hinders this development is evil; these are briefly the ethical rules of the Association. The Committee believe that they are spreading a philosophical truth which will have an elevating influence over men's minds. They therefore wish us to draw attention to the existence of the Association, and this we have now done, leaving to our readers the contemplation of the doctrine to which we have referred. The Hon. Secretary of the Association is Prof. M. Deshumbert, Camberley, Surrey.

Dr. W. L. Abbott, of Philadelphia, has been well employed during the past eight years in exploring various parts of the Old World, and sending his collections to the National Museum at Washington. Mount Kilima-njaro and the adjoining districts of East Africa were the scenes of his first investigations, after which he visited the Seychelles, and the neighbouring islands of the Indian Ocean. He then proceeded to Northern India, and passed two years in Cashmere, Ladak, and Turkestan. From all these localities numerous collections of natural history and ethnology have been transmitted to Washington, where the members of the staff of the National Museum are busy in working out the results. Two of their reports on the birds collected by Dr. Abbott have just reached us. One of them, by Mr. Ridgway, describes the specimens obtained in the Seychelles, Amirantes, Gloriosa, Aldabra, and other adjacent islands, many of which had not been previously visited by a naturalist. In Aldabra, generally known as the home of gigantic tortoises, Dr. Abbott met with forty-five species of birds, several of which are representative forms peculiar to that island. In a second memoir Mr. Richmond gives us an account of 746 "well-prepared specimens" which Dr. Abbott has accumulated in Kashmir, Ladak, and Baltistan, and refers them to 188 species. Most of these are, of course, well known to Indian ornithologists, but Mr. Richmond ventures to describe as new a Blue-throat from Ladak, under the name *Cyanecula abbotti*.

Dr. Nicola Terracciano has contributed to the Transactions of the R. Accademia delle Scienze fisiche e matematiche, of Naples, an important memoir on the flora of Monte Pollino and the surrounding district. This group of mountains, situated between Calabria and the Basilicate, has for some time attracted the attention of Neapolitan botanists, and the number of species in its flora now amounts to 1468, exclusive of varieties. Dr. Terracciano notes as new to the Italian flora, *Gagea minima* and *G. amplyopetala*, and he describes four altogether new species, namely *Fritillaria pollinensis*, *F. intermedia*, *Ornithogalum ambiguum* and *Narcissus pollinensis*, together with many other forms which he considers varietal.

The estimation in which certain gramineous species are held varies much in different countries. For instance, *Holcus lanatus*, which in Britain is universally regarded as a weed, though it intrudes abundantly upon many of our pastures, is deliberately sown in mixtures of meadow-grass seeds in France. The *Agricultural Gazette of New South Wales* (vii. 5) cites another example in the tufted hair grass (*Deschampsia cæspitosa*, Beauv.,

or *Aira cæspitosa*, Linn.). This species is locally known in England as tussock grass, and as "bull faces" or "bull pates," and efforts are constantly made to extirpate it from our permanent pastures. In Australia, however, "it affords a fair pasturage if periodically burnt down." Graziers on and near the Australian Alps have been asked to send notes of their observations of this species, as it is regarded as quite possible that the Australian plants differ in forage value from those of the northern hemisphere. The culms are sufficiently tough to permit of door-mats being made from the hay.

WHAT is known as the "shade-tree insect problem," in the Eastern United States, forms the subject of an illustrated bulletin of the Department of Agriculture at Washington. The great abundance of insects which attack shade-trees was a noteworthy feature in many of the cities in the summer of 1895. In almost every low-lying town from Charlotte, N.C., north to Albany, N.Y., the elm-leaf beetle *Galerucella luteola* defoliated the English elms, and often the American elms. The bagworm (*Thyridopteryx ephemeræformis*), the white-marked tussock moth (*Orgyia leucostigma*)), and the fall webworm (*Hyphantria cunea*) are conspicuous amongst the depredators. Some species of trees suffer much more than others, the beeches, hornbeams, and alders appearing to have few insect enemies. Spraying and banding of trees and other checks are being employed, and one of the Washington newspapers has advocated the formation of a tree protection league amongst the citizens.

A CORRESPONDENT in the *Grahamstown Journal* tells how he cleared his garden of a pest of locusts. A number of diseased insects were obtained and ground into a fine powder, which was then placed in a bucket of water. Some of the mixture was poured on a few locusts of a fairly good-sized swarm, and before many days had elapsed numbers of the locusts were found dead, and eventually the garden was quite clear of the pest.

ON account of the great success of the botanical models made by the firm, Herrn. R. Brendel, in Berlin, the same firm is now constructing zoological models out of papier-mâché, some of which are exhibited in the Berlin Exhibition this summer. For instance, there is a model of the ordinary house-fly (*Musca domestica*) thirty times life-size; it is very accurately made, and all its parts are beautifully worked and distinct, making it unnecessary to take it to pieces. By means of a small piece of mechanism the spreading of the wings can be demonstrated. There is also exhibited, in a series of eight models, a plaster representation of the development of the frog, each being ten times life-size; they are all so arranged that they can be lifted off their supports and examined more minutely. With the help of such useful models as these, students of zoology will be more easily able to grasp some points which cannot always be obtained from pictures or diagrams. These models should also be found most useful in schools where the pupils do not often come in contact with museums.

IN Italy, almost the only instruments used for the study of earthquake-pulsations are long and heavy pendulums. The greater the length the more steady is the bob during movements of the ground, and the heavier the bob the more readily is the friction of the recording pens overcome. In the last number of the *Bollettino* of the Italian Seismological Society (vol. ii., 1896, pp. 62–65), Dr. A. Cancani describes the latest form of seismometrograph constructed under his superintendence. Two instruments have been made, one for the geodynamic observatory at Rocca di Papa, and the other for that at Catania. The former is 15 metres long and 200 kg. in mass, the latter is 26 metres in length and has a mass of 300 kg.; in other respects they are almost identical. The suspending wire of the pendulum passes at its lower end through slits in the short arms of two horizontal levers. The slits are at right angles to one another, but the levers are bent at an angle of 45° in opposite directions, so that the pens at the free ends of the long arms write their component records side by side on the same moving band of paper. The paper is driven at the rate of 60 cm. an hour, a velocity great enough to allow the individual undulations to be examined, and the times of the different phases to be determined with considerable accuracy.

THE restlessness or alarm shown by birds and animals before the occurrence of an earthquake sensible to man is now well known, and is probably due to the very small tremors which precede the larger vibrations. In an interesting paper (*Boll. Soc. Sismol. Ital.*, ii., 1896, pp. 66-74), Dr. A. Cancani has collected a large number of examples observed in Italy. He points out besides the important fact that, while most animals are disturbed during and after an earthquake, it is only at some distance from the epicentre that they exhibit any signs before the shock is perceptible to man. The explanation Dr. Cancani gives is that the tremors move with a greater velocity than the large vibrations, but that a considerable space must be traversed before they have outraced the latter by several seconds.

IN the *Bulletin* of the Constantinople Observatory for January 1896, Dr. Agamennone concludes his summary of the earthquakes felt in Turkey during the year 1895 (see NATURE, vol. liv. p. 373). The number of recorded shocks amounts to 400, and these are found to belong to thirty-one seismic centres, the principal of which are near Paramythia, Imam Keuy (Aïdin), and Pergama. In the neighbourhood of Constantinople at least ten earthquakes had their origin, showing that the seismic activity provoked by the great shock of July 1894 has not yet ceased.

WE have received from Prof. G. Vicentini a new and valuable contribution to our knowledge of earthquake-pulsations, consisting of a list of the disturbances registered by his two-component microseismograph at Padua from February to September 1895. Many of these can be referred to known shocks, occurring either in Italy or in neighbouring countries. On three occasions (March 6, June 15, and July 5) the origin of the pulsations is unknown, but the diagrams are similar to those that are produced by earthquakes taking place at a very great distance. Copies of the diagrams corresponding to twenty-two earthquakes are reproduced on a scale two-thirds of the original.

IN the current number of the *Journal* of the Anthropological Institute of Great Britain and Ireland (vol. xxvi. No. 1) Mr. Robert M. W. Swan gives some very interesting notes on ruined temples in Mashonaland. These temples are of the Zimbabwe style; *i.e.* they seem to take the form of circular arcs, if not complete circles. Practically only one he describes—that of the temple at Lundi River—attains to anything like a circular shape, and this is very complete, being only pierced by two openings. The others scarcely reach 180°, and these seem always to be pierced by a doorway. The temple at Lundi River stands on a little knoll about half a mile south of the waggon road, and 300 yards towards the east of the river. It is built of small rectangular, naturally-shaped blocks of granite, laid in very regular level courses. From the fact that the inside finely-built wall supports, to some extent, many of the stones of the outside wall, it is suggested that it is probable both were built at the same time. Mr. Swan took measurements of the different parts of the building. The circumference of the temple was 169 feet $6\frac{1}{2}$ inches, or 17·17 feet $\times \pi^2$ (10 cubits $\times \pi^2$). At no point did the foundations of the temple diverge more than a few inches from a true circle. The two doorways into the building were 60 feet $8\frac{1}{2}$

inches distant from one another, the angles between the doors subtending an angle of 128° 51′ at the centre. One of the doors formed with the centre of the temple a north and south line, so that it is supposed that the wall between these two doors was intended to face the sun when rising at the summer solstice. Many other interesting points of this temple are referred to by Mr. Swan. To give some idea of the great number, he says: "From what I have said it will be seen that, along the 250 miles or so of road between the Lobsani and Lundi rivers, I have visited about twenty temples, or other remains of the people who built Zimbabwe . . . but admitting that I have seen all within a mile on both sides of the road, and that the strip of country traversed is a fair sample, as regards ruins, of this part of Africa, it is evident that the number of ruins of this class in the whole country between the Zambesi and Limpopo rivers must be enormous." Further on he says: "On a hill further on, I found four temples of the same sort, and one little crescent of rough stones carefully oriented to the sun rising at the northern solstice. In fact these temples are so numerous in this part of the country, that one might safely undertake to find a hundred of them within ten miles of Salisbury." Mr. Swan, in a postscript to his paper, suggests that these temples are not temples in the ordinary meaning of the word, but simply religious symbols, analogous, as he says, to our crosses and wayside shrines. The article contains several other points of interest, too long, however, to be dealt with here.

An extraordinary incident is reported in *Engineering*, from Terre Haute, Indiana, by the city engineer, Mr. G. H. Simpson. A street of this town was paved with brick five years ago, the joints being grouted up. The work was done partly during the winter, being finished in early spring. The foundation consisted of broken stone 8 in. thick, above which was a layer of sand 2 in. thick. At the end of last July, with the thermometer standing at about 100° F., a section of the pavement rose like an arch from its foundation, and though water was turned on to it, and openings made to let out any possible accumulation of gas beneath, it maintained its position unaffected. Men were then put to work to repair the pavement, but hardly had they removed the swollen section when, with a loud report, another section of the pavement rose in a similar manner to a height of 7 in. to 9 in.

We have received the fourth yearly report of the Sonnblick Society, containing the results of the meteorological observations made at the summit of that mountain for the year 1895. In addition to the usual obligatory observations, the observer, at the instigation of Dr. Pernter, made a special study of the crackling or humming of the telephone, and by this means, the occurrence of thunderstorms was frequently predicted. The records of this phenomenon have been discussed by Dr. W. Trabert, who finds that in all years, during the winter season, the noise gradually decreases from 7h. a.m. until noon, and then increases until about 9h. p.m.; while in the summer season the minimum occurs about 7h. a.m., from which time the humming steadily increases until 9h. p.m. The only meteorological phenomenon with which the noise can be connected appears to be the diurnal and annual range of the amount of cloud, which it closely follows; whence Dr. Trabert concludes that although it may have some connection with earth currents, it is probably primarily due to the electricity of the clouds. The report also contains good photogravures of a cumulus cloud driven by a strong wind over the Tauris mountains, at an elevation of about 10,000 feet.

A discussion took place some time ago in our columns on "The Alleged Absoluteness of Rotation." In connection with this subject we have pleasure in calling attention to a recent paper by Dr. Benedict Friedlaender and Herr Immanuel Friedlaender, bearing the title "Absolute oder relative Bewegung?" (Berlin: Leonhard Simion), in which the *pros* and *cons* of the three different hypotheses are discussed, as well as the possibility of an experimental solution of the question.

We have received from Prof. Ángel Gallardo, of Buenos Ayres, an interesting pamphlet on Karyokinesis. In it the author presents the physico-mechanical hypothesis of figures of cell-division and some of its consequences, founded on the views of recent writers, without, however, attempting to investigate the influence of this hypothesis on the more important questions of biology.

Four new volumes have been published in M. Léaute's Encyclopédie scientifique des Aide-Mémoire. In "La Distillation des Bois," M. Ernest Barillot describes the plant and processes utilised in the distillation of wood for the production of methyl alcohol, acetic acid, charcoal, tar, &c. A volume entitled "Chaleur et Energie," by M. E. Ariès, is an exposition of the principles of thermodynamics according to a method based upon the postulate that "Un système ne peut décrire un cycle fermé irréversible, à l'aide d'une seule source de chaleur, sans lui *céder de la chaleur* et sans *consommer du travail.*" The work is divided into two parts, the first dealing with the general principles of the science of heat, and the second with thermodynamics. The last chapter is devoted to the description of a general method for the application of thermodynamical principles. Lieut.-Colonel Hennebert contributes to the Series a volume on "Travaux de campagne." In this book, the author reviews the means of organisation of attack and defence of an army in the field, victualling, encampments, and the construction and use of various military works. The same author is responsible for a volume on "Communications militaires." In this, roads, navigable waters, railways, and bridges are examined successively from a military point of view, means of destruction as well as construction being described.

A prospectus has reached us giving particulars of a work on "Submarine Telegraphy," by Mr. Charles Bright, which will, provided a sufficient measure of support is obtained in advance, be published by Messrs. Crosby Lockwood and Son. The book, though based upon Wünschendorff's "Traité de Télégraphie sous Marine," has been thoroughly revised and brought up-to-date, and is practically a new work. Besides being a *résumé* of the science and practice of submarine telegraphy, both from an electrical and engineering aspect, the book contains a complete history of this particular application of science from its birth, practically speaking, in 1850 up to 1895, with a short sketch of that which preceded in land telegraphy, and a prelude concerning all early efforts connected with signalling of any description.

Messrs. Whittaker and Co. are about to publish an authorised translation, by Mr. Lucien Serraillier, of Mr. D. Farman's work on "Automobiles." The work will be fully illustrated, and contain constructional details of the latest developments in this branch of work.

Mr. Quaritch has sent to us his catalogue, dated August, of choice and valuable books offered for sale by him. The list contains particulars of very many rare and choice works relating to most branches of science.

Messrs. Simpkin, Marshall, and Co., Ltd., will, on October 3, issue the first number of *The Avenue*, a monthly illustrated magazine devoted to education, association, and social progress.

The additions to the Zoological Society's Gardens during the past week include a Squirrel Monkey (*Chrysothrix sciurea*) from Guiana, presented by Mr. A. C. Goude; a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mr. W. Stevens; three Ivory Gulls (*Pagophila eburnea*), a Richardson's Skua

(*Stercorarius crepidatus*) from Spitzbergen, presented by Mr. J. F. Studley; two Variegated Sheldrakes (*Tadorna variegata*) from New Zealand, presented by Sir Walter L. Buller, K.C.M.G.; two Streaky-headed Grosbeaks (*Poliospiza gularis*) from South Africa, presented by Miss Jessie Porter; an Oyster-catcher (*Himantopus ostralegus*), British, presented by Mr. R. Gurney; a Bordeaux Snake (*Coronella girondica*), a Common Snake (*Tropidonotus natrix*, var.) from France, presented by Mr. E. A. Minchin; a Squirrel Monkey (*Chrysothrix sciurea*) from Guiana, a Beccari's Cassowary (*Casuarius beccari*) from New Guinea, a Red Kangaroo (*Macropus rufus*, ♀) from Australia, deposited; two Otters (*Lutra vulgaris*) from Ireland, four Cayenne Lapwings (*Vanellus cayennensis*) from South America, purchased; a Chinese Mynah (*Acridotheres cristatellus*) from China, received in exchange; an African Wild Ass (*Equus tæniopus* ♀) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

DOUBLE STAR OBSERVATIONS.—In *Ast. Nach.*, No. 3370, Dr. Doberck, while discussing the elements of η Coronæ Borealis, takes the opportunity to determine the probable error that accompanies the observation of position angle and distance in the case of the better-known double star observers. Three stars have been selected for the discussion. η Coronæ, a close double, in which the probable errors are referred to a common distance of $0''\cdot7$; α Centauri, reduced to a mean distance of $10''$, and, of course, including a different class of observers; and γ Virginis, with a mean distance of $2''\cdot5$. Dr. Doberck might with advantage have given the aperture of the telescope with which the observations have been made, but a glance at the list is sufficient to show that the greatest accuracy, as might have been anticipated, is on the side of the large telescopes. In the case of η Coronæ, Profs. Hall and Burnham are the only observers whose probable errors fall below 1° in position angle. In distance, their only competitor is M. Perrotin, who also has the advantage of large aperture. With γ Virginis, where the components are more widely separated, telescopes of moderate size are able to compete advantageously, and the measures of MM. Duner and Schiaparelli appear quite as trustworthy as those of Prof. Hall. The probable errors attached to observations made in the southern hemisphere are, on the whole, slightly larger than those derived from northern observers.

VARIABLE STARS.—Owing to the rapid accumulation of new material, which seems to be coming in on all sides, Dr. Chandler thinks that a new edition of his catalogue, incorporating everything up to date, is necessary. With this we entirely agree with him; for, although the system of supplements is a good one, they *can* accumulate, and when this happens the sooner they can be eliminated the better. Our readers are so familiar with these catalogues, that little need be said when it is stated that Dr. Chandler has entirely overhauled the work, and brought in all the new material. It is good, however, to hear, as he says, that the "degree of uniformity and completeness of the observation of the phenomena, and the consequent development of our knowledge with regard thereto, during the past few years is remarkable." He adds, however, further that the need for volunteers in the southern hemisphere is pressing (*Astronomical Journal*, No. 379).

VARIABLE STAR OBSERVATIONS.—Profs. Barnard and Chandler have both called attention to possible errors introduced into the observation of variable stars from physiological causes. The latter thinks that a systematic error arising from unequal sensitiveness of different portions of the retina, dependent upon different positions of the variable star with reference to those with which it is compared at different hour angles, can be traced in the case of the minimum phase of U Pegasi. Mr. A. W. Roberts, in the *Astronomical Journal*, No. 381, urges the employment of some mechanical means for the elimination of this source of error. He himself has been in the habit of using both a negative and a direct-vision eyepiece, and taking the mean of the two observations. In this way, it is asserted, the mean error of observation has fallen from 0·12 mag. to about 0·05 mag. The obvious suggestion of employing a prism mounted behind the eyepiece, and taking four observations in such a manner that the comparison star is rotated 90° about the variable, is not lost sight of; and when this arrangement is carried into effect, it is confidently anticipated that the mean error will not be greater than 0·03 mag. It is needless to point out that this implies a greater degree of accuracy than has been attained with any photometer. The probable error in the case of the Harvard photometer has been quoted as 0·075 mag., and Drs. Müller and Kempf, with the Zöllner photometer at Potsdam, have not been able to make their probable error much below 0·06 mag. Mr. Roberts' experiment will, therefore, be watched with considerable interest.

THE CAPE OBSERVATORY.—The Observatory Report for 1895 furnishes several items of general interest. The fine equatorial, presented by Mr. McClean, is in an advanced state, the only part not yet commenced being the line-of-sight spectroscope. Besides the cylindrical observatory and hemispherical dome, the donor has generously provided a rising floor of excellent design, and also an attached building containing entrance hall, study, developing room, and instrument store. The objective prism of 24 inches aperture has been completed by Sir Howard Grubb. The chief part of the year has been occupied in clearing off arrears of reduction and publication. The publications during the year included—"The Cape General Catalogue for 1885, with Appendices, &c."; "A Determination of the Solar Parallax and the Mass of the Moon from Heliometer Observations of the Minor Planets Iris, Victoria, Sappho"; the first volume of the "Cape Photographic Durchmusterung," containing the mean places of 152,000 stars for 1875, derived from Cape photographs between Declinations −19° and −37°; a complete account of the "Geodetic Survey of South Africa." Much actual observational work has been entirely suspended to allow of these publications being completed. It is also mentioned that an increase of staff will be required for the new astrophysical department created by the advent of the McLean telescope. With the transit instrument 2872 stars have been observed, the small number being due to the objects being chiefly slow-moving circumpolar stars. The work with the astro-photographic telescope has been satisfactory. 91 catalogue plates were taken, 55 of these being finally passed. 367 chart plates were exposed, 240 being passed. This leaves 15 catalogue and 253 chart plates yet to be done to complete the complement assigned to the Cape. A complete investigation of the réseau used here (Gautier No. 8), has been made, and will soon be published. The observations made with the zenith telescope in 1892, 1893 and 1894, for aberration and change of latitude, are completely reduced, and are being finally revised.

AN INVESTIGATION ON ABERRATION AND ATMOSPHERIC REFRACTION.—The latest volume of the publications of the Washburn Observatory of the University of Wisconsin (vol. ix.) contains an investigation, by Mr. George C. Comstock, on "Aberration and Atmospheric Refraction." It may be remembered that M. Lœwy pointed out the extended use of the equatorial telescope and its adaptation to new lines of research through the introduction of reflecting surfaces in front of the objective. The method adopted here, however, deviates widely from Lœwy's, for reasons given by the author in the introduction. Instead of the employment of a prism in front of the object-glass (the fundamental idea of the apparatus designed by M. Lœwy), the reflecting surfaces of which were the silvered faces of an equiangular glass prism, Mr. Comstock substituted for it three plane mirrors of rectangular cross-section. By this means he was able to overcome the great drawback, met with when using the prism, of the deformations of the prism arising from changes of temperature, and producing errors of focus which seemed to be insuperable with this type of apparatus. A detailed description of the mirrors and method of mounting, too long to be referred to here, is given. Mr. Comstock next enters on the determinations of the errors of the apparatus, and gives tables of the instrumental constants that follow, a description and investigation of the micrometer employed, and the effect of aberration and refraction upon the apparent distance between two stars respectively. Several other points are investigated, which he found were important after a preliminary trial of the method he adopted. From the discussion of 822 observations of the angular distances separating thirty-nine pairs of stars made by two observers, it appeared, as he says, "that the apparatus as employed is capable of furnishing a very considerable degree of precision, the probable error of a single observation made under normal conditions being $\pm\ 0''\cdot30$, *i.e.* less than a millionth part of the quantity measured." As mentioned before, the observations were made to determine, from the annual variations

in the distance separating each pair of stars, a value of the constant of aberration, and a second part of the work was to make a comparison of the measured and computed distances, which would give the corrections to be applied to the refraction tables. A series of subsidiary investigations, the results of which are given on page 203, was also completed. The result of the whole investigation furnishes as a definite result: Constant of Aberration $= 20''\cdot443 \pm 0''\cdot010$, which differs only very slightly from the commonly accepted value obtained by Struve, and this within its own limit of probable error. The volume is accompanied by some excellent illustrations of the instrument and the novel dome which protects it. The second part of this volume contains the observations of the right ascensions of the stars observed with the prism apparatus made by Mr. Albert S. Flint.

NEW FEATURE ON MARS.—A telegram from Kiel announces the observation of a bright prominence on the terminator of the planet, by Messrs. Hussey and Holden, at the Lick Observatory on Wednesday last, August 27. The planet is well situated for observation at midnight, being at present some five or six degrees north of α Tauri.

THE ECLIPSE AT BODÖ AND NORTH FINLAND.

WE give this week a reproduction of the drawing of the corona made near Bodö, which accompanied Dr. Brester's letter in our last issue (p. 390).

Further particulars have been received concerning the doings of the Russian Expedition under Baron Kaulbars, which observed in Russian Finland. There was an unusually large development of the corona, the extensive and often oblique rays of which surrounded the dark disc of the moon. One of these rays reached a length double that of the sun's diameter. Some of the rays crossed each other, and Baron Kaulbars writes to the *St. Petersburger Zeitung* "that the remarkable proportions of the corona coincide with the opinion according to which this phenomenon is only very little developed with a *minimum* of sun-spots, for he had been able to see only very insignificant spots on the sun at rare moments during observations extending over several weeks."

Dr. Brester's drawing of the Corona.

Other expeditions to the Maritime Province of the Amur appear to have been very successful.

ON THE RÖNTGEN RAYS.[1]

WHO would have dreamt at the last annual meeting of the Victoria Institute, that before a year was out, we should be able to see on a screen, to receive on a photographic plate, which is afterwards developed, the skeleton, or a portion of the skeleton of a living man, or at least a living child? And as the modes of exciting these rays improve, we shall probably go on, step by step—indeed already, I believe, the whole body of a full grown man has been penetrated by these rays, the discovery of which we owe to Dr. Röntgen.

I feel some diffidence in bringing this subject before you, because I have never, myself, made experiments with the Röntgen rays. Nevertheless I have read a good deal about them, following what others have done, more especially where it connected itself with the subject of light, to which I have paid a good deal of attention. So I cannot but have a tolerably definite idea in my own mind as to the nature of these Röntgen rays which has been a matter in dispute and, I may say, is still in dispute, although I think opinions are generally coming round to that which I will bring before you in the end.

Now before I go to the Röntgen rays direct, I must touch on previous work which gradually led up to them.

For a very long time it has been known that an electric discharge passes more readily through tolerably rarefied air, than through air of greater density, and so with other gases. If we have a longish closed tube, provided with electrodes at the ends by means of platinum wires passing through the glass, if the air be tolerably exhausted from it, an electric discharge passes, comparatively speaking, freely through it, forming a beautiful skein of light, if I may so speak, and under certain circumstances that skein of light is divided into strata in a very remarkable manner. These strata fill the greater part of the tube from the positive electrode, or anode, as it is called, till we get nearly, but not quite, to the negative electrode, or kathode. There is a dark space separating the end of the positive discharge which, as I said, under suitable conditions and sufficiently high exhaustion, shows stratification, from a blue glow enveloping the negative electrode or part of it. The luminosity about the kathode is somewhat indefinitely bounded on the side of the stratification.

When, however, the exhaustion is carried still further, at the same time the strata become wider apart, and the luminosity recedes from the kathode and expands, forming a sort of glowing halo much more sharply defined on the inside than the outside; in that respect resembling the ordinary luminous halo—not the corona—occasionally seen round the moon. We have here, then, these two dark spaces, one outside the halo, where the luminosity gradually fades off, and another dark space on the inside, where the luminosity is more sharply defined, and which reaches to the negative electrode.

Now it is the phenomena in connection with this second dark space that I have more particularly to bring before you. As the exhaustion is rendered higher and higher, the inner dark space gets wider and wider until at a sufficiently high exhaustion it fills the whole tube or bulb. Mr. Crookes has worked more especially at this subject, and, indeed, the tubes which are now used for the production of the Röntgen rays, are generally called "Crookes tubes." I have seen in some of the foreign periodicals the word "Crookes" used to signify one of these tubes. Mr. Crookes' researches in very high vacua led him up to that most remarkable instrument, the radiometer, the nature of which led us to form clearer conceptions, than we had hitherto done, of the nature of the motion of molecules in gas; or rather, when the theory of the radiometer was made out, presented us, as I may say, with a visible exhibition of the thing in actual working.

Now these researches, which led Mr. Crookes to improve his vacuum, naturally led him to examine the electrical phenomena produced by excessively high vacua.

I have said that it was with the second or inner dark space that I had chiefly to do. When the exhaustion is sufficient, that fills the whole tube.

Now what takes place in this dark space? Suppose we interpose a screen, such as a plate of mica with a hole in it. A portion of the discharge from the negative electrode goes through that hole and continues onwards in a straight course until it reaches the wall of the tube. When it reaches the wall

[1] An extract from the Annual Address to the Victoria Institute, by Sir G. G. Stokes, F.R.S., the President.

of the tube (I will suppose the tube, as it is called, to be made of German glass) it produces a greenish yellow fluorescence, or phosphorescence of very brief duration. I need hardly say that if you do not limit what comes from the negative electrode by the screen with a hole in it, you get a broader beam which affects the glass wall over a larger space.

Now what is it that proceeds from the negative electrode towards the glass, and, when it gets there, produces this phosphorescence? Is it light, or is it matter?

One remarkable circumstance connected with this *something* is, that you can deflect it in its course by a magnet. If you present a magnet to a ray of light it does not deflect it at all; but this *something* is easily deflected by a magnet, even by a tolerably weak magnet. Mr. Crookes found that in addition to that property, if this discharge of a something fell upon one side of a very light fan, formed of thin, split mica, and delicately mounted so as to enable it to spin readily, it sent it spinning round; and he believed that the nature of that which we have here to do with is, that it is a stream of molecules. Nobody, I suppose, denies that there is matter propelled; but there has been a considerable difference of opinion as to whether the matter propelled is of the essence of the phenomenon, or whether it is something merely accidental. Mr. Crookes held that it was of the essence of the phenomenon, and that we had here, really, a stream of molecules, and I must say, for my own part, I believe he was right. But some foreign men of science hold that the projection of matter is altogether a secondary phenomenon, and that what comes through this small hole is really only a process which goes on in the ether—something so far of the nature of light, but yet differing from ordinary light most markedly in the property of being deflected by a magnet. To illustrate what I mean by saying something secondary, Prof. Wiedemann, who holds the opinion that it is of the nature of light, or a process going on in the ether, imagines that the projection of matter has no more to do with the phenomenon than the path of a cannon ball has to do with your hearing the sound of the cannon. I think, myself, that it has a great deal more to do with it than that. However, I will leave that matter for the present, to pass on to some researches which led up to the remarkable discovery by Dr. Röntgen.

In Germany, Prof. Lenard made a very remarkable series of experiments in what the Germans call, and what we may call, the kathodic rays, and which he believed to be actual rays, and not streams of molecules sent from the kathode. In order to produce these rays, as I will call them, you want a very high vacuum. If, however, you make your vacuum too high and too nearly perfect, you cannot get the electric discharge to pass through it. A perfect vacuum appears to be a non-conductor, and if you attempted to make the electric discharge pass through it, it would go, by preference, on the outside from one electrode to the other, so that you cannot work directly with anything too nearly approaching to a perfect vacuum. But it is a very remarkable thing, though Lenard, I believe, was not the first to discover it, but Hittorff, that these kathodic rays pass or appear to pass through a plate of aluminium which is perfectly impervious to light, or even to the ultra-violet rays, which we know by their effects, though we do not see them directly; so that you may have these kathodic rays at one side and something of the same kind at the other. Lenard constructed an apparatus commencing with a Crookes tube, in which there was very high, though not too high, exhaustion, with a kathode which was either flat or cup-shaped at one end, and opposite to that, in the part where the kathodic rays would strike the glass if it were there, instead of glass it was closed by a thin plate of aluminium foil, so thin that it would support the atmospheric pressure although it was impervious to air. But as a continuation of that tube he had another tube, which was also capable of exhaustion. The two tubes had glass tubes leading from them to the same air-pump. There was communication with the air-pump and communication between the two tubes, and you could exhaust them together, and the pressure would be so far reduced that the aluminium plate was strong enough to sustain the reduced pressure. They were both exhausted together until a suitable exhaustion was produced for the production of the kathodic rays in the first tube, and then the connection between the two tubes was intercepted, and the exhaustion of the second tube, which was kept connected with the air-pump, was continued for several days, until, as near as he could get it, there was nothing at all, in the way of gas, left in it. What was the result? In the first tube the kathodic rays were produced by the electric discharge. They fell on the aluminium foil at the end, and then there was a continuation of kathodic rays in the highly exhausted tube—the vacuum tube I will call it—and these went on as if they had been rays of light. They were deflected by the magnet just like the original kathodic rays.

Now at first sight that looks very much as if you had to deal with actual rays, which passed through the aluminium foil, just as rays of light would pass through a plate of glass. But I think the real explanation of it is altogether different. I believe it to be of this nature. First I will use rather a gross illustration, in order that you may the better apprehend the nature of the other explanation that I am about to bring before you. Suppose that I have a row of ivory balls in contact, such as billiard balls, and that another similar ball strikes the first of these. The result is that the last of the balls is sent off, and the striking ball and the intermediate balls remain approximately at rest. Now it is conceivable that something analogous to that may take place as regards these so-called kathodic rays, supposing they are not rays at all, but streams of molecules. It is conceivable that the molecules proceeding from the kathode or negative electrode of the first tube, be they of residual gas, or aluminium, or platinum, might fall upon the thin aluminium plate which forms a wall between the two tubes, separating the one from the other, and that that would give rise to molecular discharge in the second space, although the actual moving molecules never passed through the wall. As I say that is a rough illustration—rather a gross and material illustration—to enable you to understand more clearly the view I have to bring before you.

I have said that the so-called kathodic rays are easily deflected by a magnet. Now we know from other experiments that if a body sufficiently charged with electricity is in rapid motion, and that motion takes place in a magnetic field, the body tends to be deflected. This looks, therefore, very much as if these kathodic rays are actually streams of molecules, which being highly charged electrically, and of almost inconceivable minuteness, would be deflected by a slight magnetic force. Now, if these highly-charged molecules come to strike on the aluminium wall which separates the two tubes (which are end to end) from one another, it may be that an electrical action goes on which resembles very much what electrolysis is supposed to be according to the views of Grotthuss. I shall not have time to enter into an explanation of that now, for it would lead me too far from the subject; but several present will no doubt understand what I mean when I refer to the views of Grotthuss. The molecules then impinge on the wall, and give rise to a projection of molecules from the second side of the wall, but the latter are not the same molecules which impinged on the first side of it. Whether the molecules projected in the second tube come from a very minute quantity of residual gas, or whether they are derived from the aluminium wall itself, from which they are torn, as it were, does not signify for my purpose. We have here, you see, a conceivable mode of emitting these so-called rays in this way, simulating the transmission of a ray of light through a plate of glass, though it is no ray at all that we are dealing with. I confess I think that that is the true view of the action which takes place. But Lenard himself believed that the kathodic rays were, as he said, processes in the ether. By means of the first tube used alone, as was done in the first instance, but closed with a "window" of somewhat thicker aluminium foil, so as to sustain the atmospheric pressure, he was able to receive the kathodic rays which came from the second surface of the aluminium foil in air, where he could examine them at pleasure, using for their detection sometimes a phosphorescent or fluorescent screen, sometimes a photographic plate. He found that under these conditions they were quickly deflected from their original direction and dispersed, so that they could not be traced far, just like rays of light in a turbid medium, such as water to which a little milk has been added; whereas in a subsequent series of experiments, to which reference has already been made, in which the kathodic rays were received into a second tube, the dispersion became less and less as the exhaustion proceeded, until at the highest attainable approach to a perfect vacuum the dispersion almost disappeared, and the rays were traced right onwards for a metre and more, and that, without being enlarged by diffraction, as would be the case with rays of light.

Lenard mentioned incidentally that these kathodic rays, as he supposed they were, were able to pass through the hand even. He missed the discovery of the X rays because he had,

I may say, the kathodic rays too much in his head, and attributed the whole effect on either side of the wall to the kathodic rays. Really the effect is due in part to the kathodic rays, and in part to the Röntgen rays, the existence of which he was not aware of. They cannot be distinguished merely by their effect on a fluorescent screen or on a photographic plate, since both these recipients are affected by the rays of both kinds.

Such was the state of things when Röntgen made his remarkable discovery. According to an account which I saw in one of the newspapers (we cannot vouch for the truth of everything we see in the newspapers), the discovery was made in the first instance accidentally. I cannot give you more authentic information than that, but he had been working with a Crookes tube and he observed that a photographic plate, enclosed in the usual case in which these plates are enclosed when you want to protect them from light, showed on development certain markings an it ; so he put the whole apparatus as it had been, with a photographic plate in its case in the same position as before, and the thing was repeated. That is according to the account in the newspapers. A very remarkable discovery was the result. He found that rays were capable of coming out of some part of a Crookes tube which had the remarkable property of passing through substances that are opaque to ordinary light, and opaque even to the ultra-violet with which we were previously acquainted. They pass freely through black paper, through cork, wood, or even through the flesh of the hand, though less freely through the bones, so that by simply laying his hand upon the case containing the photographic plate, he actually got a photograph of the bones of his hand.

Well, what is the nature of these rays and from whence do they come? As Röntgen said in his original paper, a slight examination shows that they have their origin in the part of the Crookes tube opposite to the kathode, and which is rendered phosphorescent by the discharge from the kathode.

The rays, however, which come from this part of the tube, and which appear to have their origin there, differ utterly in some respects from the so-called kathodic rays. If you isolate a portion of them, you find that a magnet has no action upon them ; unlike the kathodic rays, they proceed onwards without deflection, just as if the magnet were not there. Like light they proceed in a straight course, but these rays are able to pass through a variety of substances that are opaque to ordinary light, while on the other hand they are stopped by other substances which let light freely through. That, however, does not prove that they are not of the nature of light. You may have, suppose, a red glass which is opaque to green rays, but lets red rays through very freely, so that as regards merely the fact of the X rays being stopped by substances transparent to light, while they pass more or less freely through other substances which are quite opaque to ordinary light, that establishes no greater distinction than exists between green and red light. Are they then of the same nature as light?

The X rays have some very remarkable properties by which they appear at first sight to differ *in toto* from ordinary light. They pass with either no refraction, or excessively small refraction, through prism-shaped bodies, which we know rays of light do not. They suffer hardly any, if any, regular reflection, unless perhaps at a grazing incidence.

Röntgen himself, in his original paper, dwelt on these peculiarities of the new rays. He formed a prism of aluminium, with which he attempted to obtain deviation of the new rays, but the experiment showed that if there were any deviation at all, at any rate the refractive index could not exceed 1·05. He speaks of the rays not being apparently capable of regular reflection, but he brought forward experiments which show that in a certain sense they appear to be capable of reflection.

A photographic plate with the sensitive surface downwards was placed in its case under a Crookes tube, and immediately under the plate, and inside the case, were placed portions of different kinds of metal, which would be capable of reflecting back the rays on to the sensitive surface, if they admitted of reflection ; and it was found that the plate was much more darkened over certain of those metals than where the metal did not exist. There was very little darkening over aluminium, and a great deal of darkening comparatively over platinum. This indicated that some effect was produced, though the greater part of it is not one of regular reflection. He conceived the effect to be one of reflection such as you might have from a turbid medium.

There is, however, another mode of explanation which seems worth considering, viz. that the Röntgen rays, falling upon the metal, throw the molecules into a state of vibration, which they communicate to the ether, by a sort of phosphorescence or fluorescence of X light ; so that the rays which come from the molecules, though perhaps not of exactly the same nature as the X rays that fell upon them, still have enough of the "X" quality about them, whatever that is, to enable them to get through objects which are opaque to ordinary light.

Lord Blythswood, who has worked a great deal with the Röntgen rays, has written a paper, which was communicated to the Royal Society by Lord Kelvin, in which he establishes a minute regular reflection of those rays from speculum metal at an angle of about 45°. Two plane specula were placed side by side so as to receive at that angle the X rays coming from a Crookes tube, and a duly protected photographic plate was placed in such a position as to receive the regularly reflected rays if there should be any. The developed plate appeared to show a slight indication of the junction between the mirrors ; and that the appearance was not illusory was shown by Lord Kelvin, who made measurements on the image and compared the results with what they ought to be on the supposition of a regular reflection. The indication was so faint that I could not myself perceive it (I have not seen the negative, but only positive copies), but Lord Blythswood has given me some positive copies of a negative which he subsequently obtained by reflection from a concave speculum at a small angle of incidence, and which show for certain a minute regular reflection of X rays, while at the same time they prove that the quantity of X light returned by regular reflection is extremely small compared with that which comes from the mirror by some different process.

Now there is another remarkable property of these rays, or absence of property, if you like so to call it. Rays of light, as we know, admit of diffraction. If you pass light from a luminous point through a very small slit, or a small hole, the riband, or the beam of light at the other side, does not follow merely the geometrical projection of the slit or hole as seen from the source of light, but is more or less widened, and certain alternations of illumination are visible, a phenomenon referable to interferences which I have not time to go into. How do these X rays behave under such conditions? It is a very remarkable thing that they do not show these enlargements or exhibit any sign of interference.

The last number of the *Comptes rendus* contains a paper by M. Gouy in continuation of a former paper, but describing experiments carried out in a still more elaborate manner, which proves the truth of this to a very high degree of strictness. He makes out that if these X rays are periodical, the wave-length cannot well be more than the one-hundredth part of the wave-length of green light, indicating an enormously high degree of frequency.

Now, if we assume that the X rays, like rays of light, and unlike the kathodic rays, are a disturbance propagated in the ether, ponderable matter being concerned only in their origination, not in their propagation, the question arises, What is the relation between the direction of vibration and the direction of propagation? Are the vibrations normal or transversal? We know that the vibrations of the air which constitute sound take place in a to and fro direction, or are what is called normal—that is, perpendicular to the waves of sound. We have the fullest evidence that the vibrations of the ether which constitute light take place in directions perpendicular to that of propagation, or are what is called transversal. To which category do the vibrations belong which constitute the X rays?

If we could obtain polarisation, or even partial polarisation, of the X rays, that would settle the question, and prove that they are due to transversal vibrations. But most of those who have attempted to obtain indications of their polarisation have failed. This, however, does not prove that the vibrations are normal, for the peculiar properties of the X rays shut us out—or, at least, almost completely shut us out—from the ordinary means of obtaining polarisation. There is, however, one paper in the *Comptes rendus*, by Prince Galitzine and M. de Karnojitsky, in which the authors profess to have obtained by a special method undoubted indications of polarisation. No reasonable doubt can remain as to the abstract capacity of these rays for polarisation after what has been done by another physicist. I wish I had time to go into the experiments that

have been made by M. H. Becquerel in the direction of polarisation; but I have already kept you too long. He had more particularly studied a very remarkable phenomenon, viz. that certain phosphorescent bodies—such as sulphide of calcium, for instance, and salts of uranium—on exposure to ordinary sunlight give out rays of some kind which pass through bodies opaque to light, and are able to affect a photographic plate beneath them. So far these agree in their properties with the X rays which are obtained from a Crookes tube, which they far more closely resemble than they do rays of ordinary light; but the rays thus obtained were found by Becquerel to admit of polarisation by means of tourmalines in a manner altogether unmistakable. I think, therefore, that we may take it as established that the Röntgen rays are due to some kind of transversal disturbance propagated in the ether.

The non-exhibition of the ordinary phenomena of diffraction and interference is explicable on the supposition that the vibrations in the X rays are of an excessively high order of frequency. I am not sure that a different sort of explanation might not, perhaps, be possible which I have in my mind, though I have not matured it; but, save the possibility of that, one is led to regard them as consisting of transverse vibrations of excessively high frequency. This opens out some points of considerable interest in the theory of light; but I am afraid it would keep you too long if I were to attempt to go further into this matter. I will merely remark that, taking the way in which these rays are most commonly produced, viz. as coming from a point where the kathodic discharge in the Crookes tube falls on the opposite wall, we may understand how it is that vibrations of excessively unusual frequency may be produced. These highly charged molecules, charged with electricity, coming suddenly against the wall, may produce vibrations of a degree of frequency which we are not at all prepared for; but I see by the clock that I must not detain you any longer on speculations.

Postscript.—This "different sort of explanation" is one between which and the supposition of periodic vibrations of excessively high frequency my mind has for a long time oscillated. In the above lecture I gave the preference to the latter; but subsequent reflection leads me strongly to incline to the former. I hope before long to develop fully these views elsewhere; meanwhile, suffice it to say that I am disposed to regard the disturbance as non-periodic, though having certain features in common with a periodic disturbance of excessively high frequency.

THE ICE VOYAGE OF THE "FRAM."

DR. NANSEN has communicated to the *Daily Chronicle*, by telegraph from Tromsö, some interesting details given by Captain Sverdrup, with reference to his voyage in the *Fram*. The marvellous way in which the *Fram* withstood the ice-pressure, and the methods employed to free the ship from the ice, is an object-lesson for future Arctic explorers. The telegram is abridged below.

On March 14, 1895, Nansen and Johansen left us. During the first month after their departure, the ice was very quiet and the drift inconsiderable. Towards the end of April the drift, however, improved, and we were carried westwards. On July 26 the *Fram* was in 84° 50′ N., and 73° E. long. There was during this time much ice-pressure, but it never reached the ship. Then we had winds from south-west and west, which during the summer drifted the *Fram* backwards towards the east and north-east. It was not before October that the favourable drift recommenced, and during the autumn and winter, and especially during January and the first part of February 1896, our drift was better than ever.

On October 16, 1895, the *Fram* had reached the highest latitude observed, viz. 85° 57′ N., and 66° E. long. In the middle of February we were on 84° 20′ N., and 23° E., but here the drift closed until May, when we were again carried southwards. On July 19 we had reached 83° 14′ N., and 14° E. long.

There we got the *Fram* out of the grasp of the ice by blasting with gun-cotton and powder, and began to force our way southwards. During the whole drift in the ice the *Fram* was exposed to constant and violent pressures. None of these were, however, so dangerous as that which we had at New Year before Nansen left us. Immediately after his departure we were occupied in removing the huge mass of ice which on that occasion was pressed against the *Fram's* sides. At the end of March, just as the last portion of this ice was being removed, the ice suddenly cracked in all directions round the ship, and a broad water-lane was formed, which came within a few feet of the *Fram's* stern. Strong pressure very soon began along this crack, and the ice was so much broken up that the *Fram* at the end of July lay close to open water. A single mine was sufficient to free the ship from the ice.

As this mine was exploded, the *Fram* glided from the ice into the water like a ship being launched from her ways, but with a noise like thunder, the crew cheering loudly as she struck the water. Having been brought into a safe harbour by warping and sawing the ice, she was again, in August, frozen in. The ice-pressures were, during this year, of no great importance in comparison with the pressures this last summer.

During one week in June this summer (1896), at the height of the spring tides, the *Fram* was regularly exposed to violent pressures caused by the changing tide-currents. She was then once or twice a day lifted 6 to 9 feet, and her bottom could be seen resting on the ice. On all these occasions the *Fram* proved to be the very ship for ice. She was quietly lifted, and not a noise or a crack was heard from her timbers. The men on board were not disturbed in their slumber, even when the pressure was at its highest, and we awoke in the morning in ignorance of what had happened during the night. It was not before we came on deck that we observed how high we were lifted above the ice.

The temperature of the air was pretty even during our whole voyage, and did not fall lower than during the first winter. The depth of the sea was during our drift about the same as we had found before Nansen's departure, viz. 1800 to 1900 fathoms. In the temperature of the sea there was also little change, but the warm layer of Gulf Stream water under the cold surface-water increased a little in body as we came westwards. Depôts of provisions, boats, kayaks, and all necessary equipment were during our whole drift kept in readiness on the ice in the neighbourhood of the *Fram*, in case of fire or other accidents.

The time passed comfortably and peacefully, much in the same way as during the first winters. An easier expedition can hardly be imagined. Our principal work was to take the regular observations, sleep, eat, and drink. Our health was perfect the whole time, and we had no sign of scurvy. When the ice began to slack a little this summer, we worked hard to loosen the *Fram* from the ice—a difficult task, owing to the huge ice, piled up by pressures, in which our ship was frozen. We succeeded, after some days' hard work, by blasting, using mines of up to 100 lb. of powder. Guncotton proved the best.

From July 19 to August 13 we forced our way southwards through 150 miles of close ice. The ice was, as a rule, very high, and the floes were so extensive that we could not see all of them, even with telescopes. It often seemed to be hopeless, and if the *Fram* had not been such a superior ship for ice-navigation it would have been quite useless to try to force our way through ice-masses of such a description. It was by steam and warping that we broke our way through foot by foot, and where the ice was too bad for this it was forced by blasting.

We came out of the ice on August 13—the same day on which Nansen and Johansen arrived at Vardö in Norway.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Lords of the Committee of Council on Education have appointed Mr. A. J. R. Trendell, C.M.G., to be Assistant-Secretary of the Department of Science and Art, in succession to Mr. G. F. Duncombe, retired. Mr. Edward Belshaw succeeds Mr. Trendell as the Chief Clerk.

THE retirement of Prof. Erismann from the chair of Hygiene in the University of Moscow, is announced.

COLONEL PENNYCUICK, late R.E., has been appointed President of the Engineering College, Cooper's Hill, in the place of General Sir Alexander Taylor, retired.

THE following announcements have been recently made:—Dr. Burney Yeo, to be Professor of Medicine, and Dr. Curnow, to be Professor of Clinical Medicine at King's College, London.

A SCHEME for a Central Technical College in Liverpool, for which the plans have already been accepted, now awaits the

sanction of the City Council. The estimated cost, apart from the final equipment, amounts to £80,000.

THE syllabus of lectures at the British Institute of Preventive Medicine, for the Session 1896-97, has just been issued, and contains particulars as to the work in the following departments:—Bacteriology: (1) Bacteriology in relation to Medicine and Pathology; (2) Bacteriology in relation to Hygiene; (3) Biological Chemistry; (4) Original Research Work: Hygiene, Clinical Investigation, Bacteriology of Fermentation, Water Laboratory, and Photomicrography.

THE following appointments have recently been made at the Swansea Technical School:—Lecturer in Metallurgy, Allan Gibb, Honours Associate in Metallurgy of the Royal College of Science. Lecturer in Physics, W. Williams, B.Sc. (London), Senior Demonstrator, Physical Department, Royal College of Science. Lecturer in Engineering, T. Gilbert Jones, B.Sc. (Vict.), Wh.Sc., &c., Lecturer in Applied Mechanics and Steam, Huddersfield Technical School.

AMONG recent appointments abroad we notice the following:—Prof. Thomas A. Williams, of South Dakota, to be Assistant in the Division of Agrostology of the Department of Agriculture; Mr. F. S. Earle, to be Professor of Biology at the Alabama Polytechnic Institute; Dr. Karl Rümker, to be full Professor of Agriculture in the University of Breslau; Dr. F. W. Küster, to be Professor of Physical Chemistry in the University of Göttingen; Dr. Wm. Sandmeyer, to be Professor of Physiology in the University of Marburg; Dr. Max Fischer, to be Professor at the Agricultural Institute at Leipzig; Dr. Richard Lorenz, to be Professor of Electro-chemistry at the Polytechnic Institute at Zürich; Herr Troske, to be Professor of Engineering at the Technical High School, Hanover; Dr. J. Biehringer, to be Docent in General and Technical Chemistry at the Technical High School, Braunschweig; Dr. Benecke, to be Docent in Botany in the University of Strasburg.

THE *Calendar* of the People's Palace, East London, Technical College for the Session 1896-7, contains information concerning all the classes which are to be held next winter, and their name seems to be legion. Not only can the student of pure science receive instruction in any branch from thoroughly competent teachers, but also the person desirous of help in learning how to make artificial flowers for bonnets, or how to cut out a coat. We fancy it would be difficult to name a subject which does not come within the syllabus of this technical school. We refer the students of East London to the *Calendar* itself for information concerning scholarships, exhibitions, fees, &c.

THE City of London College, Moorfields, has issued its list of classes to be held during the forthcoming session, and a very full syllabus of lectures proposed to be given in the Engineering Laboratory of the same establishment has reached us.

PARTICULARS of the technical instruction lectures and classes organised by the British Horological Institute, Northampton Square, London, E.C., have been published for the session, which commences on September 8. They include drawing and theory classes held at the Institute on Tuesday and Thursday evenings, or instruction in theory by correspondence. Ordinary and honours theory examinations, held at the end of April in each year, are opened to all engaged in the horological trades. Certificates are issued to watch and clock repairers who satisfy the examiners of their proficiency. The certificates will be of two classes, both for watches and clocks: an ordinary and an honours certificate. Practical examinations in new work will be held annually in April, and the silver medal of the Institute will be awarded to recipients of the honours theory certificate and the practical certificate for new work, who obtain the largest aggregate number of marks in both examinations.

THE Aberdeen County Council, says *Education*, is making careful inquiry at various fishing centres as to the extent to which the County Councils in England have provided technical instruction for fishermen. The Cornwall County Council spends between £500 and £600 per annum on this branch of their work, and they have appointed a lecturer to give instruction on the curing of herring and pilchards; the natural history of crabs and lobsters, mackerel, oysters, and salmon; the making of crab-pots, splicing and net repairing, and so on; and to supervise demonstrations on oyster and lobster culture at Falmouth. Instruction is also provided in the subject of navigation, with a view to the examinations of the Board of Trade. The Essex County Council have started a marine biological station at Brightlingsea, to give practical instruction in the natural history of food fishes and other creatures. Experiments are also conducted in oyster culture, and lectures and demonstrations are given at the station. In Lancashire and Northumberland instruction has been given on the natural history of fish and navigation. At the conference, which was held last December, the proposal was put forward that a few practical fishermen should be selected from different centres in Aberdeenshire, and enabled to visit the more important fishing centres with a view to acquiring, and afterwards extending, a knowledge of the different methods of fishing, the treatment of fish after capture, preservation, and so on.

THE Department of Science and Art has issued the following lists of Scholarships and Exhibitions just awarded:—Whitworth Scholarships (tenable for three years), £125 a year each: Frederick C. Lea (24), engineer; William A. Taylor (23), engineer; Henry T. Davidge (24), engineer; John W. Hinchley (25), student (formerly engineer). Whitworth Exhibitions (tenable for one year), £50 each: William Du Bois Duddell (23), engineering student; John A. Sloan (23), engineer; Alfred J. White (20), engine-fitter apprentice; Hugh Wallace (21), engineering student; Edward A. Gere (22), student; Frank W. Arnold (23), engineering teacher; Hugh B. Phillimore (22), electrical engineer; Hanson Topham (19), mechanic; Harry E. Wimperis (19), engineer; Charles E. Handy (19), engine-fitter apprentice; Bertram J. Rouse (22), engine fitter; Frank H. Corson (19), fitter apprentice; Thomas G. Procter (20), engineering student; Harry Geldart (21), mechanic; Hector H. Garratt (20), engineer apprentice; George Wall (22), engineering student; George W. Howe (20), electrical engineer apprentice; William W. Firth (21), engineering student; Harry Grute (22), fitter; Hugh J. Williams (23), turner; Frank Mould (24), engine fitter; Frank H. Jeffree (22), engineer; Denys Walton (19), engineer apprentice; Allan J. Grant (20), engineer; William G. Hibbins (24), engineer; Joseph P. Ward (21), engineer; George L. Overton (21), student; Asa Binns (22), fitter; Albert Pidgen (23), fitter; William P. Ferguson (21), fitter.

THE list of successful candidates for Royal Exhibitions, National Scholarships, and Free Studentships (Science) is as follows:—National Scholarships for Mechanics: Ernest Larmuth (17), student; Raymond B. Smith (17), engineering student; John B. Shaw (22), engineer; Frederick J. Tyler (22), engineer apprentice. National Scholarships for Chemistry and Physics: Henry L. Heathcote (19), student; James M. McEwen (17), solicitor's clerk; Arthur Hopwood (21), hatter; Percy Hughes (18), laboratory assistant; Sydney W. Smith (18), student. National Scholarships for Biological Subjects: Herbert Wright (21), weaver; Wilfred Thomas (20), laboratory assistant. National Scholarships: Alfred J. White (20), engine-fitter apprentice; James Walker (23), engineer; John Cresswell (19), student; Ernest W. J. Edwards (17), assistant demonstrator of physics; Archie McDougall (17), laboratory assistant; Frank E. Smith (19), laboratory assistant; George J. Fenwick (17), scholar; Hugh McDougall (19), laboratory assistant; Frank W. Arnold (23), engineering science teacher; Hanson Topham (19), mechanic; Harry E. Wimperis (19), engineer. Royal Exhibitions: William Alexander (20), engineer apprentice; William Scholes (16), student; Thomas G. Madgwick (18), engineering student; William Robertson (19), laboratory assistant; Charles E. Handy (19), engine-fitter apprentice; William Pickering (22), stonemason; George A. Robertson (22), engineering student. Free Studentships: Frank Jowett (18), student; Percy Kenyon (17), student; George W. Howe (20), electrical engineer apprentice; Frank Mould (24), engine-fitter; Philip G. Gundry (18), student; Allan Macdiarmid (22), student.

SCIENTIFIC SERIAL.

American Journal of Mathematics, vol. xviii. No. 3. (Baltimore, July.)—On the multiplication and involution of semi-convergent series, by Prof. Cajori. In vol. xv. Prof. Cajori has generalised Voss's results (*Math. Ann.*, vol. xxiv. p. 42), and some further contributions of his to this difficult subject are given in the *Bulletin* of the Am. Math. Soc. (vol. i. pp. 180–183). The search, he

remarks, for expeditious tests on the applicability of Cauchy's multiplication rule to powers of semi-convergent series higher than the second power, has given rise to the present investigation, which begins with alternating semi-convergent series, and ends with certain trigonometric series.—Analytic functions suitable to represent substitutions, is an interesting following-up of a theorem due to Hermite (*Comptes rendus*, vol. lvii. p. 750), by L. E. Dickson. Further generalisations are promised in a dissertation by the author.—S. Kantor contributes an elaborate memoir, "Theorie der Transformationen im R_r, welche sich aus quadratischen zusammensetzen lassen," which has as heading, "Boldness is caution in these circumstances."—Tactical Memoranda, i.-iii., by E. H. Moore, is the opening one of a series of papers which the author proposes to publish, on certain more or less closely connected topics of tactic. He starts from Cayley's division of algebra into tactic and logistic. This instalment bears upon the work of Reze (Geometrie der Lage), S. Kantor, Klein, and many others; it also gives a generalisation of the *fifteen-schoolgirls* arrangement, and considers whist tournament arrangements, which are in ultimate formulation purely tactical.

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, August 17.—M. Marey in the chair.—On the copper mines of Sinai, worked by the ancient Egyptians, by M. Berthelot. These mines are near the coast of the Gulf of Suez, and are undoubtedly the most ancient known to history, having been worked at least 5000 years before the Christian era. They were abandoned about 3000 years ago, on account of the small amount of copper present in the ores. The reduction appears to have been carried out by methods not differing essentially from those in use at the present day, wood being used as the reducing agent, together with fusible silicates.—On the subject of a preceding communication, relating to some properties of primitive roots and secondary roots of prime numbers, by M. de Jonquières.—On an apparatus for aërial navigation, by M. Honoré.—Abstract of solar observations made at the Royal Observatory of the Roman College during the first half of 1896, by M. P. Tacchini.—Combination of argon with water, by M. P. Villard. When argon is compressed to 150 atmospheres in the presence of water cooled to 0°, local cooling at a point in the tube causes the separation of crystals, probably a hydrate, the dissociation tension of which at 0° is 105 atmospheres. Nitrogen and oxygen also combine with water under similar conditions, but at much higher pressures.—On the reticular structure of central nervous cells, by Mdlle. Wanda Sczawinska.—Contribution to the study of the coagulation of the blood, by MM. J. Athanasiu and J. Carvallo. It is concluded that in the normal state the blood and lymph contain elements, perhaps leucocytes, which supply the fibrin ferment necessary for the coagulation of these liquids, and that when these elements are prevented by any means, such as peptone, from fulfilling this function, the tissues are capable of replacing them.—Influence of certain substances upon the bactericidal properties of the blood, by M. London. The bactericidal power of the blood is markedly reduced by want of food, but increased by small repeated doses of sodium bicarbonate.—On the extraordinary refractions observed in the neighbourhood of lakes, and known under the name of *Fata Morgana*, by M. André Delebecque. The apparent enlargement of objects on the opposite bank of the lake is really due to the superposition of a number of images which, although not distinguishable by the unaided eye, are clearly separable by the aid of a telescope.—On the resolution of the general equation of the fifth degree, by M. L. Mirinny.

August 24.—M. A. Cornu in the chair.—M. Tisserand gave an account of the results of the observations made of the total eclipse of August 9. The results obtained by M. Deslandres at Yeso, and by Mdlle. Klumpke, at Vadsö, were unfavourable, but M. Backlund, of the Observatory of Pulkowa, was able to make some good observations at Novaya Zemlya.—On the transformations of the equations in dynamics, by M. Paul Painlevé.—On a proposition in mechanics, by M. F. Siacci.—On a doubly recurring series of points always homocyclic, by M. P. Serret.—On the electric convection following the lines of force produced by the Röntgen rays, by M. Aug. Righi. Experiments are described which tend to show the existence of a convection following the lines of force.—The utility in radiography of a screen coated with phosphorescent sulphide of zinc, by M. C. Henry. The zinc sulphide screen, wrapped in carbon paper, is covered with the object to be examined and exposed to the radiation of a Crookes' tube for some minutes. On removal to a darkened room the image shines for at least a quarter of an hour, so that the smallest details of the image can be made out. The light emitted by glow-worms was found to be capable of penetrating blackened paper, and affecting a sensitive plate underneath.—The quaternary beds of the Micoque, by MM. G. Chauvet and E. Rivière.—Note on magnesium sulphide, by M. N. Bignan.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—British Association, Liverpool, 1896: Handbook to Liverpool, &c. (Philip).—An Archæological Survey of the United Kingdom: Dr. D. Murray (Glasgow, MacLehose).—On the Adjustment and Testing of Telescopic Objectives, 2nd edition (York, T. Cooke).—The Principles of the Transformer: Dr. F. Bedell (Macmillan).—"Made in Germany": E. E. Williams, 3rd edition (Heinemann).—Entomological Notes for the Young Collector: W. A. Morley (E. Stock).—British Butterflies: J. W. Tutt (Gill).—Elements of Astronomy: Sir R. S. Ball, new edition (Longmans).

Pamphlets.—Les Applications de L'Electrolyse a la Métallurgie: M. U. Le Verrier (Paris, Gauthier-Villars).—Vierter Jahres-Bericht des Sonnblick-Vereines, 1895 (Wien).—Arithmetic for Promotion, Scheme B: Lock and Macdonald, Part 5 (Macmillan).

Serials.—Science Progress, August (Scientific Press).—Royal Natural History, Part 34 (Warne).—Strand Magazine, August (Newnes).—Journal of the Royal Microscopical Society, August (Williams and Norgate).—Quarterly Journal of Microscopical Science, August (Churchill).—Longman's Magazine, September (Longmans).—Good Words, September (Isbister).—Sunday Magazine, September (Isbister).—Lloyd's Natural History. British Birds: Dr. R. B. Sharpe, Parts 3 and 4 (Lloyd).—Humanitarian, September (Hutchinson).—Chambers's Journal, September (Chambers).—Scribner's Magazine, September (Low).—Natural Science, September (Page).—Journal of the Royal Horticultural Society, Vol. xx. Part 1 (Victoria Street).—History of Mankind: F. Ratzel, translated, Part xi. (Macmillan).—Modern Astrology, September (Bouverie Street).

CONTENTS.

THURSDAY, SEPTEMBER 10, 1896.

RECENT ORNITHOLOGY.

A Vertebrate Fauna of the Moray Basin. By J. A. Harvie-Brown, F.R.S.E., and T. E. Buckley, B.A., F.Z.S. 2 vols. Pp. xx + 262 and 309. (Edinburgh: David Douglas, 1895.)

British Birds' Nests: How, where, and when to find and identify them. By R. Kearton, author of "Birds' Nests, Eggs, and Egg Collecting." Introduction by R. Bowdler Sharpe, LL.D. Illustrated from Photographs, by C. Kearton, of Nests, Eggs, Young, &c., in their Natural Situations and Surroundings. Pp. xx + 368. (London, Paris, and Melbourne: Cassell and Co., Ltd., 1895.)

British Sea Birds. By Charles Dixon. With eight illustrations by Charles Whymper. Pp. ix + 295. (London: Bliss, Sands, and Foster, 1896.)

A Hand-book to the Birds of Great Britain. By R. Bowdler Sharpe, LL.D., Assistant Keeper, Zoological Department, British Museum. Vol. iii. Allen's Naturalist's Library. Pp. xii + 338. (London: W. H. Allen and Co., Ltd., 1896.)

"THE Vertebrate Fauna of the Moray Basin," by Messrs. Harvie-Brown and Buckley, is the latest addition to the series being issued by them on the Vertebrate fauna of Scotland. They have already given us the Vertebrate fauna of Sutherland, Caithness, and West Cromarty; of the Outer Hebrides; of the Orkney Islands; and of Argyll and the Inner Hebrides. When we get, as we are promised before long, that of West Ross and Skye, and of Shetland and Dee, the northern parts of Scotland, so far as the section of its fauna with which our authors concern themselves, will be complete.

The area dealt with in the present volume is extensive, embracing "all the country drained by the rivers flowing into the Moray Firth . . . including the greater part of Sutherland, Ross, Inverness . . . Banff, Moray and Nairn." "We have endeavoured," say the authors, "from within our own narrow horizons in this, as in previous volumes of the series, to indicate the importance of natural areas and boundaries as determining to a large extent the faunal values." The greater part of the first volume, therefore, describes the water system, topography and physical features of the Moray Basin—"whose landward portion [is] hemmed in by some of the highest mountains of Scotland, and its seaward area similarly enclosed by the funnel-shaped contours of the shores"—and discusses the relation of these to the resident and migrant species inhabiting it. Forty-two species of mammals, 255 of birds, and nine of reptilia and amphibia are enumerated from the Moray Basin, with lengthy and valuable notes on their distribution, dates of breeding, and habits. No account is given of the marine or fresh-water fishes, beyond incidental mention, but we have an important chapter by Dr. R. H. Traquair, F.R.S., on the extinct vertebrates found in the different geological formations in the region, illustrated by several plates of restorations of the fishes for which the rocks of the Moray Basin are remarkable.

Such small defects as a style somewhat discursive, and sentences often rather involved and occasionally less pellucid than could be desired, will be readily forgiven the two naturalists who have laid their brethren under great obligations by this addition, which can hardly be too highly praised, to their valuable series of local faunas of Scotland. In addition to the palæontological plates, and several of nests and nesting-places of birds, excellently reproduced by process, these volumes are embellished by a number of exquisite photogravures (by Annan, of Glasgow) of scenery in the Moray region interesting to the naturalist. No book deserves to be commended—even if good otherwise—which fails to provide a full index and, where topography is dealt with, a good map. Both are to be found in "The Moray Basin." The map, which includes Scotland north of latitude 56½°, by Bartholomew, whose cartographical fame is world-wide, is beautifully clear yet full of detail. For all that is excellent in the publisher's art and craft, the name of David Douglas, by whom these volumes are given out, is sufficient guarantee; and they are worthy companions to their predecessors in the well-known sport and natural history series, issued from Castle Street, Edinburgh.

The book second on our list, by the brothers Kearton, owes its existence to a series of photographs of British birds' nests and eggs taken "in their natural situations and surroundings." They claim theirs as "the first practical attempt to illustrate a manual on the subject from photographs taken *in situ*," and characterise their pictures as "unique." Surely we have before the appearance of this volume had bird-articles illustrated by process blocks of birds' nests and eggs in their natural situations; and has not Mr. Welch, of Belfast, published a charming series of photographs of birds' nests taken also *in situ?* The manual before us, whose letter-press is from the pen of Mr. R. Kearton, presents us with the species-breeding in this country arranged in alphabetical order, and gives a short description of the parent birds (whose scientific names are, we regret to see, omitted), of the locality, situations and materials of the nest, and of the colour and size of the eggs and their time of laying—all sufficiently accurate, and of much value where the authors speak from personal observation. The illustrations, of which there are over a hundred, most of them well printed, are from photographs by Mr. C. Kearton. They by no means illustrate the nests of all the birds described in the text; but, on the other hand, those of many species are given which few even of those who are bird-lovers are likely ever to see unless they make a special journey for that purpose. Mr. C. Kearton has spent an enormous amount of time, energy and perseverance, and overcome troubles and disappointments of no ordinary kind, and he has bravely—occasionally foolhardily—hazarded his life, poised on the slender tops of high trees, or dangling from the face of precipices, in obtaining illustrations for his book. We agree with Dr. Sharpe, who, in the commendatory preface by which he introduces our authors to the public, remarks that the way in which they have overcome the very serious difficulties presented by their task "proves that in addition to the native British pluck, the

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true love of natural history is necessary to accomplish such a result as they have achieved." Much as we admire the one, and feel in fellowship with the other, we cannot help saying that the results are ornithologically unsatisfactory, and expressing what we have long realised, that photographs direct from nature are not the best means of representing birds' nests and eggs. So little of the surroundings can, as a rule, be got into a half-plate, that it is difficult, if the nest and eggs are to be visible at all, to form any true idea of the situation or of the materials of the nest; nor, except under very favourable circumstances, can a standard of size be introduced to correct, as is so often needed, the retinal impression. Unless also the photograph be taken perpendicularly above the nest, which is unsatisfactory, the eggs cannot be seen in the nest unless they are elevated or, what is equally to be deprecated, the nest be tilted, as in the song-thrush's on page 299. If, again, we compare the nests of the gadwall and the pheasant, the character, form and uniform surface of the eggs are so similar, that both nest and eggs might belong to either bird; and a "Skylark's nest on the crown of a furrow," conveys the impression of being situated on the face of a rocky wall. There seems to be greater scope for the "photographic naturalist" in dealing with nestlings. The young "Grey-lag geese" and the "Golden eagle's eyrie, with young," are both delightful.

Notwithstanding these defects in some of the illustrations, inseparable from the process employed, or due to the awkward places whence the views were photographed, this volume, which is attractively produced, will doubtless have a wide circulation among young British ornithologists.

Mr. Charles Dixon, who appears under the auspices of a different publisher than heretofore, claims audience with a new book, "British Sea Birds," in which we are pleased to find fact more plentiful than fancy. It has been our far from pleasant duty oftener than once to criticise adversely the theories and speculations he has advanced. On the present occasion, however, we feel considerable gratification in being able to recommend his chatty articles on the birds to be found along our coasts. There is nothing new or striking in the volume; but it will prove an agreeable and instructive companion to many of those who, during their sea-side holidays, take an interest in the birds they meet with, and desire to know something about them. Besides describing our strictly marine birds, Mr. Dixon contributes a chapter on land birds that are constantly to be found frequenting the shore or the cliffs. The volume is very prettily got-up and illustrated by eight excellent full-page plates by C. Whymper.

The third and penultimate volume of Dr. Sharpe's "Handbook to the Birds of Great Britain," in Allen's Naturalist's Library, concludes his account of the ducks (*Anatidæ*), and describes the herons, storks and ibises (*Ardeiformes*), the cranes (*Gruiformes*), and the bustards and plovers (*Charadriiformes*), in all ninety-two species. The present volume maintains the high standard of excellence of its predecessors; but the illustrations, though perhaps as good as can be expected for the exceedingly low price at which each volume is published, are not above criticism.

BRITISH MOSSES.

The Student's Handbook of British Mosses. By H. N. Dixon, M.A., F.L.S.; with Illustrations and Keys to the Species by H. G. Jameson, M.A., Author of the "Illustrated Guide to British Mosses." Pp. xlvi + 520; 60 plates. (Eastbourne: Sumfield, 1896.)

THIS book appears to us a very useful one. The author observes that Wilson and Berkeley are out of date, that Hobkirk's synopsis is too compressed to be of great service to the less practised collector, and that Braithwaite's great work is expensive and at present incomplete. There is, therefore, room for a new work on the subject, and the present volume appears to be a very praiseworthy attempt to fill the vacant space.

The work consists of a brief introduction; a glossary; a key to the genera; a description of the orders, genera, and species; an index, including synonyms; and 60 pages of plates. The key to the genera is intended to help a student to discover the genus of his specimen, and is based on practical considerations and not on system. The student should, perhaps, be warned not to suppose that there is more than an accidental connection between the genera which get thrown together by this process. The first group to which the student is referred is headed "A. Leaves distichous, inserted in two rows on the stem," and under this we find the genera Schistostega belonging to the order Schistostegaceæ, Swartzia belonging to the Dicranaceæ, and Fissidens belonging to the Fissidentaceæ. For the purpose of aiding the student in his hunt, this method of dealing with prominent features of the plant is very convenient. In the body of the book the name of the genus under consideration is printed at the top of the right-hand page, and in the text the genera are numbered throughout; if the number were also printed at the top of the page—thus, "12 Swartzia," or "xii. Swartzia"—it would make the process of turning to the genera from the key to the genera much easier and quicker.

Another suggestion which we venture to make to the authors for the second edition relates to the index. If one wants to see the plate illustrating, for instance, *Hypnum aduncun*, one must either look through the plates till it is found, or one must go to the index; from that to p. 458 of the treatise, from which there is a reference to Tab. lvi. O. If the index gave the following entry, "*Hypnum aduncun*, Hedw., 458, lvi. O," the reader would be saved this trouble, and the index would serve both for plates and text.

In dealing with the genera, our author gives us not only a description of the genus, but a table dichotomously arranged as a guide to the several species; and in his descriptions, both of genera and species, he has adopted the very useful practice of printing in italics the salient and most distinctive characters.

Mr. Jameson, whose useful illustrated guide to British mosses we reviewed in March 1894, has aided Mr. Dixon in the preparation of this work. He has re-written the keys to the genera and to the species, and the plates to the present work are based on those of Mr. Jameson, but have been re-drawn, and in many cases improved and added to.

We have not, of course, made use of this new volume practically; but from what we see of it, we should, without hesitation, recommend it to any person beginning the delightful study of mosses as the most likely of all those within our knowledge to suit his needs. E. F.

OUR BOOK SHELF.

Catalogue of the Described Diptera from South Asia. By F. M. Van der Wulp. 8vo. Pp. 220. Published by the Dutch Entomological Society. (The Hague: M. Nijhoff, 1896.)

COMPARATIVELY few entomologists interest themselves in *Diptera*, and therefore the number of species of the order enumerated in the present catalogue is only 2889, and doubtless represents only a small percentage of those actually existing in the rich fauna which it samples; for the *Diptera* are probably the third most numerous order of insects, surpassed only, according to the indications of our present knowledge, by the *Hymenoptera* and *Coleoptera* in the total number of species which they may be expected to include. Prof. Van der Wulp is recognised as one of our first living authorities on *Diptera*, and his work will prove of great use to specialists, especially as M. Bigot's "Catalogue of the *Diptera* of the Oriental Region," published in the *Journal* of the Asiatic Society of Bengal for 1891 and 1892, is both imperfect and inaccurate. The introductory part of the work is written in English, and includes a "Review of the Literature of Oriental Dipterology" and a bibliographical list of books and papers consulted. There is also a table of contents at the beginning, and an index of families and genera at the end. We cannot have too many books of this description; for although the number of undescribed species of insects is enormous, it is perhaps even more important to attempt to keep pace with the rapidly-accumulating mass of descriptive matter by means of carefully compiled monographs and synonymic reference catalogues, than to confine our energies to piling up additional descriptions by the hundred or the thousand.

W. F. K.

History of Modern Mathematics. By David E. Smith. (London: Chapman and Hall, Ltd., 1896.)

"HIGHER Mathematics," edited by Mansfield Merriman and Robert S. Woodward, is a text-book for classical and engineering colleges, and is a work containing 600 pages. Each chapter is written by a different author, and is devoted to some special branch of mathematics; chapters i., ii., iii., &c., dealing with solutions of equations, determinants, and projective geometry respectively. The eleventh and last chapter, a reprint of which we have before us, is written by Mr. David E. Smith, of the Michigan State Normal School, and deals with the "history of modern mathematics." Of course it has not been intended here to give a complete history of modern work, but just a sufficient survey of the whole domain to give a student an intelligent idea of the way in which the more recent advances have been made, and the ends gained thereby. Each mathematician has, as a rule, his own speciality; but each of these is one link in the chain which, when put together, forms the whole. Such a history as Mr. Smith gives here fulfils this point, and its shortness and conciseness will be favourable to students of mathematics. The text is increased in value by the numerous footnotes, and a short bibliography is given at the end; this latter is, however, by no means complete, as the author remarks, but he gives references for those who wish to go further afield. For a biographical table of mathematicians he refers to Fink's "Geschichte der Mathematik," p. 240, and for the names and positions of living mathematicians to the "Jahrbuch der Gelehrten Welt," published at Strassburg.

Graphical Calculus. By Arthur H. Barker. (London: Longmans, Green, and Co., 1896.)

A VERY timely book; and useful to instructors in the elements of the subject in providing a number of apt and eloquent illustrations of fundamental ideas. It represents a series of lectures addressed to engineering students, liable to be repelled by pure abstractions, and preferring concrete representations in which their ideas can take root; a complete contrast to the ordinary mathematical text-book of the school of Todhunter. The author should point out that the gradient of 1 in 100 (p. 13) means an angle whose tangent is 0·01 only in the indoor mode of reckoning on a plane; but that in construction of the railway, the angle is made with a sine of 0·01; the two modes of measurement are indistinguishable practically.

Integration is introduced simultaneously with differentiation, as in many respects a simpler idea to grasp; we can realise the growth of a tree at the end of a year, although the rate of growth is imperceptible. Our ordinary mathematical text-books make the mistake of keeping integration in the background too long. G.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Utility of Specific Characters.

I MUST confess to still feeling some difficulty in understanding my friend Prof. Lankester's position, notwithstanding his explanations.

The correlation principle was arrived at by Mr. Darwin after a careful examination of a large body of facts. I quote the carefully considered words in which he sums up his conclusions:—

"Correlation is an important subject; for with species, and in a lesser degree with domestic races, we continually find that certain parts have been greatly modified to serve some useful purpose; but we almost invariably find that other parts have likewise been more or less modified, without our being able to discover any advantage in the change. No doubt great caution is necessary in coming to this conclusion, for it is difficult to overrate our ignorance on the use of various parts of the organisation; but, from what we have now seen, we may believe that many modifications are of no direct service, having arisen in correlation with other and useful changes." ("Animals and Plants under Domestication," vol. ii. pp. 354–5.)

It does not appear to me that there is anything in this which conflicts with the doctrine of the "utility of specific characters." The non-useful parts of the correlated chain (if any) are sustained by the useful, and the *whole* seems to me part of the "specific character." If Prof. Lankester had no other object but to call attention to Mr. Darwin's correlation principle, I think this was a little superfluous, for it is part of the mere grammar of Darwinism.

But the point of his speech at the Linnean Society, and of the subsequent account he gave of it in NATURE, appeared to me to go a good deal beyond this, and to be of considerable interest and importance.

In the cases cited by Mr. Darwin, the correlated structures are almost all, to use Prof. Lankester's words, "obvious and measurable." This we would expect in the correlated variation of homologous parts on which Mr. Darwin lays such stress, and which form the bulk of the instances which he gives.

Prof. Lankester's "suggestion" was that "obvious species marks may be only superficial and non-significant phenomena correlated . . . with other less obvious but really important life-saving peculiarities, which might well escape the observation of the describer of specific characters." He then adduces Wells's theory as "a case which seemed to [him] most striking and suggestive in connection with the utility of specific characters." And so I think it is. I ventured to express an opinion that if established it would prove very damaging to, at any rate, the universatility of that doctrine. I certainly supposed that that was Prof. Lankester's object in bringing it forward.

He now adds that he might as well "have used any of the other cases collected by Mr. Darwin." It is not a very material point, but I do not find that Mr. Darwin makes any reference to Wells's theory in his discussion of correlation, nor do I see any in the body of the sixth edition of the "Origin of Species," though a passage is quoted from Wells's paper at p. xi. of the "Historical Sketch" which is prefixed to it. It had, however, independently occurred to Mr. Darwin, and he discusses it in a somewhat different connection in the "Descent of Man" (i. pp. 242–245). He remarks:—"That the immunity of the negro is in any degree correlated with the colour of his skin is a mere conjecture; it may be correlated with some difference in his blood, nervous system, or other tissues." And he concludes:—"I endeavoured with but little success to ascertain how far it held good." Elsewhere he gives cases to show that "differences in colour are correlated with constitutional differences." But these, though interesting, seem to me too obscure to found any definite conclusion upon. And no attempt is made to show on what material basis, subject to variation, the constitutional difference depends.

The correlation principle as originally defined dealt then with obvious and measurable characters. It is extended by Prof. Lankester's "suggestion" to what is obscure, may be unknown, and perhaps unknowable. In considering the probable utility of any specific character we shall, if the extended principle be accepted, be always open to the objection that we cannot show that the character is not the outward and visible sign of some unobservable internal peculiarity. But that is a position which I do not think we are bound to accept till something more than a hypothetical case has been established.

To sum up: Mr. Darwin based the correlation principle on what is concrete and tangible; Prof. Lankester extends it to what is intangible and hypothetical. It is not a question of what is "apostolic and orthodox," but of what is susceptible of reasonable proof.

As I do not propose to continue this discussion any further, I will take the opportunity of saying that I think it is a matter for regret that, as Prof. Lankester was present at the meeting of the Royal Society when Prof. Weldon's paper was read, he did not deliver himself on that occasion of his somewhat belated criticism. Prof. Weldon's work is of extraordinary interest, and one cannot but admire the self-sacrifice with which such laborious investigations have been prosecuted. If they want a defence, I think the following passage from the "Origin of Species" supplies it.

"It may metaphorically be said that natural selection is daily and hourly scrutinising, throughout the world, the slightest variations; rejecting those that are bad, preserving and adding up all that are good; silently and insensibly working, *whenever and wherever opportunity offers*, at the improvement of each organic being in relation to its organic and inorganic conditions of life. We see nothing of these slow changes in progress, until the hand of time has marked the lapse of ages, and then so imperfect is our view into long-past geological ages, that we see only that the forms of life are now different from what they formerly were." (Sixth edition, pp. 65–66.)

I do not myself see how the slow and ordinarily imperceptible, but inevitable action of natural selection can be demonstrated except by the statistical method. But, firmly as I believe in the inevitableness of that action, I confess that the results attained by Prof. Weldon surpassed my expectations. I am unable to agree with Prof. Lankester, that the investigation does not satisfy the canons of scientific inquiry. The hypothesis on which it appears to me to be based is, that the mean configuration of any organism at any moment is an optimum. In order to test that by the statistical method, the choice of measurements is a mere matter of convenience.

W. T. THISELTON-DYER.

Kew, August 29.

Thermometer Readings during the Eclipse.

I STARTED on July 30 in the *King Harold*, and arrived at Vadsö on August 6. On board this vessel, amongst others, were Prof. Rambaut and Dr. Hugh R. Mill, of the Geographical Society, who I see has sent a note which appears in NATURE of August 27, as to some observations of temperature he took during the eclipse. I was constantly with Prof. Rambaut on the island at Vadsö, and he particularly requested me to observe the temperatures of sun, and shade thermometers during the eclipse at the position he had taken for his observations, which were specially directed to the degree of polarisation of different parts of the corona. I enclose a diagram of my observations, which Prof. Rambaut has suggested I should send to NATURE, should you think they are worth recording. The fall of the sun thermometer (which unfortunately was fully shaded by cloud) was, from 4h. 10m. to just after totality, 2°, and its recovery

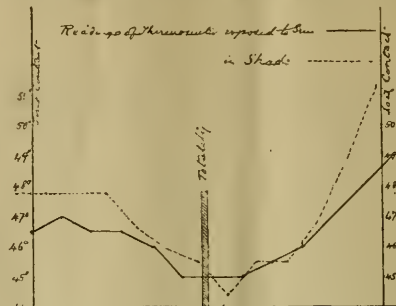


Diagram of observations of sun, and shade thermometers during the eclipse of the sun, August 9, taken at Vadsö.

from that point to 5h. 56m., last contact, was 3°·6. The shade thermometer showed greater variations, viz. a fall of 3°·35, and subsequent rise at 5h. 50m. of 5°·6.

H. WOLLASTON BLAKE.

8 Devonshire Place, W., September 3.

Sailing Flight.

MR. PEAL (NATURE, vol. liv. p. 317) having again brought up this matter for discussion in the columns of NATURE, I would like to make a new suggestion concerning it, which I have long had on my mind. It will be remembered that Lord Rayleigh (NATURE, vol. xxvii. p. 534) assumed an increase of wind-velocity with altitude to explain the facts of circular soaring, and that quite recently Langley (*Amer. Journ. Sci.*, vol. xlvii. p. 41) has tried to explain the same phenomenon by the assumption—supported in his case by direct observation—that the velocity and direction of the wind is subject to great and rapid changes. Concerning this latter statement, I must say that although in a thunderstorm great irregularities can be observed in the upper air-currents, the shape and relative constancy of small clouds in fine weather seem to show that under ordinary conditions the upper air-currents are much steadier than Langley assumes, and that, therefore, soaring birds can by no means always depend on the presence of wind-irregularities sufficiently great to sustain them. Although no doubt wind-velocities generally increase with altitude, I do not believe that such an increase will *always* be present, nor that it will, when present, be usually sufficiently great to produce the force necessary for raising a bird. We observe, however, that birds do soar nearly always, perhaps even more frequently in fine weather, when the currents are more steady, than in rough weather, when they are more irregular.

Under these circumstances it seems to me that neither Lord Rayleigh's nor Langley's assumptions concerning the source from whence these birds derive the power of overcoming gravity can be correct. It seems to me, doubtless, that a steady horizontal wind of equal velocity in different altitudes *does* enable them to soar and to rise. It is remarkable that this soaring without loss of elevation is always accompanied by *circling*. Elevation is not known to occur without circling, as it might if Langley's views were correct. Were the bird attached to the earth by a string like a kite, it could be and, if the wing-planes were placed in proper positions, would be sustained and raised by a purely horizontal and steady wind. Now it seems to me that the *circling replaces the string*. A circling top retains its position on account of the force in its rapidly circling parts. Could not the soaring bird produce—through circling—a similar stability which, acting like a kite-string, would enable it to oppose itself to the wind, and thus convert the horizontal wind-force partly into a vertical, lifting force? Mr. Peal, in his last letter (*l.c.*) very correctly remarks that the connecting-

line of the wing-tips does not lie horizontally, but obliquely, so as to describe in moving, a cone, apex downward. This slant gives, through the resistance of the air, a certain degree of rigidity to the system represented by the soaring and circling bird, which corresponds to the rigidity that holds the parts of the top together, and prevents them from flying off in tangents.

Being myself a zoologist, and not a mathematician, I cannot venture to state this hypothesis otherwise than in the shape of a question; perhaps one of the mathematical readers of NATURE will kindly take the trouble to answer it.

Czernowitz, August 23. R. VON LENDENFELD.

THE CONWAY EXPEDITION TO SPITZBERGEN.

THE expedition organised by Sir Martin Conway for the exploration of the interior of Spitzbergen left London on June 2, and first sighted the island on June 17, the exact tercentenary of its discovery by Barentz. The northern ice sheet having broken up exceptionally early this year, the floes off the western coast of Spitzbergen were unusually heavy, and somewhat delayed the arrival in Advent Bay. The expedition landed the stores there on June 20. In accordance with the plan of operations arranged, the members divided into two parties: one party, consisting of Sir Martin Conway, Mr. E. J. Garwood, a well-known geologist and Alpine photographer, and the writer, proceeded to cross Spitzbergen to the east coast. The other party, composed of Mr. Trevor Battye, the ornithologist with the expedition, and Mr. H. E. Conway, the artist, cruised about Ice Fjord and its two chief bays, in order to collect birds and make sketches.

Till the present year very little was known of the interior of the country. The coasts have been carefully surveyed by many expeditions, of which those of Parry and of various Swedish explorers, notably the series organised by Baron Nordenskiöld, are of the first importance. But hitherto the only contributions to our knowledge of the interior were those of the late Gustav Nordenskiöld and M. Rabot. The former marched for three days across the ice-sheet from Hornsund to Bel Sound, along a line parallel to the west coast and some miles inland. M. Rabot made a three days' excursion up a valley going inland from the head of Sarsen Bay. With these exceptions, exploration had been limited to the coast, and to within a day's march of it. Sir Martin Conway therefore took out two ponies and sledges, with which to provision some inland camps. The ponies answered well, but the sledges broke down repeatedly, and thus greatly delayed progress.

The principal geographical work of the expedition was the first crossing of Spitzbergen, from Advent Bay to Agardh Bay. The country traversed was mapped by Sir Martin Conway, while his two companions worked out the geology of the country and made collections of its flora and of its very limited fauna. Subsequently the whole expedition sailed northward to the Seven Islands, and through Kinlopen Strait and across Olga Strait to near King Charles' Islands. An effort to complete the circumnavigation of Spitzbergen was nearly successful, but failed owing to the passages into Sta Fjord being blocked by fast ice. Mr. Garwood and Mr. Battye ascended Hornsund Sind, the highest peak in Spitzbergen.

In regard to the biological results, it is too early to estimate their value, for novelties can only be expected among the invertebrates, which have not yet been examined. The only land mammals are the bear, arctic fox, and reindeer, of which the last are abundant. Birds are individually numerous, but the species are few; of the twenty-five authentically recorded species, we saw all but the snowy owl (*Nyctea nivea*). One addition to the list might have been made, had we been able to carry a gun across the island; for we saw an unrecorded species on the shore of Agardh Bay. Several dredge hauls were made in Advent Bay and Hornsund, yielding various species of worms, mollusca, crustacea, ophuiroids, &c.

Botanical collections were made during the traverse of the island in order to contrast the flora of the inland valley, of the high plateaus, and of the nunataks, with that of the coast. The flora is remarkably uniform, and the influence of height has less effect than those of situation and season. The species found on the mountain summits in the middle of the summer were the same as those found on the coast at the beginning of the spring. As the season advanced the species first found in flower on the lowlands and in sheltered valleys were succeeded by another set; but at any time it was only necessary to seek exposed and barren positions, or to climb above the snow line, to find the first flora still in flower.

Spitzbergen offered better opportunities for geological than for either zoological or botanical work. The rock sequence includes representatives of the Archæan, Lower Palæozoic, Devonian, Carboniferous, Trias, Jurassic, and Middle Tertiary. The coast series has been described by many workers, including Keilhau, Torell, Loven, Lamont, Nordenskiöld, Nathorst, de Geer, and others; but as the interior had not been visited, we had there a fresh field of work. In this I had the good fortune of the co-operation of Mr. E. J. Garwood; together we mapped the belt of country between Advent Bay and Stor Fjord, and made collections from each of all the geological systems that occur in Spitzbergen. Our work was greatly facilitated by the simplicity of the geology of the country; the sections are numerous and clear, and the structure is often shown with diagrammatic clearness.

Our best opportunity for the study of the Archæan rocks was given by the bare cliff sections at Walden Island, one of the Seven Islands situated in lat. 80° 38′. Here we found that this series was formed of a group of schists which have been invaded by two sets of intrusive gneisses; great blocks and seams of the schists are included in the gneisses, while veins from the latter cut upward into the schists.

The general stratigraphical sequence has many points of interest. Great stress is often laid on the absence from Spitzbergen of any indication of glacial action in times earlier than the Pleistocene; and also on the fact that the occurrence of fossil coral reefs, and beds containing warm, temperate, or even sub-tropical plants, shows that the climate before the Pleistocene epoch was quite different from that of the present time. Our evidence, however, greatly simplifies the task of explaining these difficulties; that remarkable changes of climate have happened, is unquestionable. One such is probably in progress still. But these changes of climate are reduced to much narrower limits than seems to be generally considered. We found signs of glacial action in the deposits of, at least, two different eras before those of the "great ice age." Moreover, the so-called coral reefs are not coral reefs, and might have been formed in the adjoining seas; and the fossil plants do not indicate so mild a climate as those of the Miocene beds of Southern Greenland. In fact, the whole of the fossil faunas and floras from the Devonian onward are comparatively poor in species, and appear to have lived under unfavourable conditions, and their existence in Spitzbergen may all be explained by the assumption of only a sub-arctic climate.

One of the main temptations Spitzbergen offers to the geologist is a magnificent opportunity for the study of glacial action; for we may see there marine and land ice working side by side. As our time on the coast was short, we naturally saw most of the inland glaciers. These are very different from those of Switzerland; for example, they have practically no *névé* fields. All the snow that falls on the collecting-ground at the head of the glacier turns to ice *in situ*. Time after time we ascended glaciers, expecting to be soon stopped by

reaching snow-covered crevassed ice; but, to our surprise, we found that the apparent *névé* field was a slope of ice reaching to the col, or the mountain summit. We naturally devoted much attention to a comparison of the deposits accumulated by marine and land ice. Both lay down glacial beds of very varied characters. We had no difficulty in finding cases of the formation of typical boulder clay by land ice. We also kept in mind the questions of the possibility of the uplift of material through ice, and of the existence of a differential flow in glaciers. To take one case of the former: in the moraine lying on the eastern face of the "Ivory Gate Glacier" we found many fragments of shells which had been lifted above the level of the old sea beaches, whence they had been derived. This supplied us with one clear case of the uplift of material, and the sections round the snout of this glacier left no doubt as to the method by which this is effected. The proof of a differential flow in glaciers is even more conclusive; the evidence of the extent and importance of such movements strikes us as the most impressive fact in the glacial geology of Spitzbergen. Many of the glaciers terminate with precipitous faces; these show that the layers of ice have the false-bedded arrangement that is familiar from photographs of the Greenland glaciers. Study of the sections shows that beds of englacial drift are being uplifted or carried in a direction different from that of the main movement of the ice. As we climbed and sketched the face of the "Booming Glacier" at the head of Advent Vale, we could not but recall Mr. Goodchild's paper on the "Glacial Phenomena of the Eden Valley" (1872); for we could see deposits of the same characters as those he there describes being formed by ice, acting in the way which he there assumes it must have acted.

The raising of beach material is also effected by the stranding of bergs and floes upon the sea shore; but the range of this action is not very great. The Spitzbergen walrus and seal hunters and fishermen agree that ice is never forced on shore more than one hundred yards inland, or to a height of over fifty feet.

Marine glacial deposits occur in many parts of Spitzbergen; but moraines formed in the sea differ from those formed on land—by their shape, by the character of the material, and its arrangement.

It is, perhaps, unnecessary to add that the glaciation of Spitzbergen was solely due to a local glaciation. We found no evidence of any great polar ice cap. Had any such have existed and overridden Spitzbergen from the north, we ought to have seen its traces. On the contrary, along the north coast the ice movement was from south to north.

J. W. GREGORY.

THE LAST DAY AND YEAR OF THE CENTURY: REMARKS ON TIME-RECKONING.

THE late Astronomer Royal, Sir George Airy, once received a letter requesting him to settle a dispute, which had arisen in some local debating society, as to which would be the first day of the next century. His reply was: "A very little consideration will suffice to show that the first day of the twentieth century will be January 1, 1901." Simple as the matter seems, the fact that it is occasionally brought into question, shows that there is some little difficulty connected with it. Probably, however, this is in a great measure due to the circumstance that the actual figures indicating the century are changed on January 1, 1900, the day preceding being December 31, 1899. A century is a very definite word for an interval, respecting which there is no possible room for mistake or difference of opinion. But the date of its ending depends upon that of its beginning. Our double system of backward and forward reckoning leads to a good deal of inconvenience. Only the other day I was reading in a high-class scientific periodical (the *Journal* of the Astronomical Society of Wales), that the Athenian expedition under Phocion to succour Byzantium (attacked by Philip of Macedon) took place in B.C. 339, and that that was now exactly 2235 years ago.[1] But it is evident that as there was no year 0, and B.C. 1 immediately preceded A.D. 1, the interval from any date in a B.C. year to the same in an A.D. year is found not by simply adding the respective years, but by afterwards subtracting 1 from this sum. Our reckoning supposes (what we know now was not the case, but as an era the date does equally well) that Christ was born at the end of B.C. 1. At the end of A.D. 1, therefore, one year had elapsed from that event, at the end of A.D. 100, one century, and at the end of 1900, nineteen centuries.

Believing that our Lord was born in the autumn or towards the end of B.C. 5, I once stated that our ordinary reckoning was five, not four, years in error, because the interval from a given date in B.C. 5 to the same in A.D. 1 is five years. But I was properly pulled up for saying so, because our reckoning supposes that Christ was born in B.C. 1, and B.C. 5 is the fourth year before that, so that if we could now revert to the correct year of the Nativity, the present year would be 1900, *i.e. the nineteen hundredth year after the birth of Christ.* At its close nineteen centuries from that event would be completed, and the twentieth century commence with January 1 next year, which would be called 1901. Here is where the apparent difficulty comes in. Some people fancy that the year 1900 means 1900 years after the birth of Christ; but the years are in fact ordinal, not cardinal, numbers, and the century is completed, not at the beginning, but at the end of that year. The mistake is of the same kind as if we should conclude from a man being, for instance, in his sixty-second year that he was sixty-two years old. A recent writer in the *Times* points out that though the same argument applies to the hours of the day, we do in fact use cardinal numbers in this respect; and when we say, for instance, 4 o'clock in the afternoon, we mean that four whole hours have passed since noon, whereas by analogy with the number indicating the year, we might mean the fourth hour. This of course is what the Germans do, in speaking of time between two consecutive hours, *halb vier*, for instance, with them meaning half-past 3, or the fourth hour, half gone. But it would be impossible to designate by half-*past* 4, for instance, half an hour or thirty minutes in the fifth hour or of hour five; and the French idiom equally necessitates counting the portions of an hour from the hour as a cardinal number.

It is clear then that the year, as we call it, is an ordinal number, and that 1900 years from the birth of Christ (reckoning it as we do from the end of B.C. 1) will not be completed until the end of December 31 in that year, the twentieth century beginning with January 1, 1901, that is (to be exact), at the previous midnight, when the day commences by civil reckoning. The writer referred to above, truly says that in speaking of months of the year and days of the week we also use ordinal numbers; but in these, when that method of designating them is used, we actually say so, and call them the first or second, &c., month or day. The year, on the other hand, is always spoken of as a cardinal number; but probably this is on account of its number being large. Had the reckoning from the true or supposed date of the birth of Christ been commenced in the first century, the years would doubtless have been called, like those of the reign of a king or queen, the first, second, &c., or fiftieth, sixtieth, year. In mentioning the hours of a day, the matter becomes somewhat different, because we see them

[1] The expedition really took place late in the summer of B.C. 340, and there may be a misprint here. The article is in reference to a medal struck at Byzantium, representing an occultation which occurred at the time, and is the origin of the present Turkish standard.

marked and hear them struck on a clock. We think therefore of an hour not as an interval of time, but as an instant, which is that of the completion of the hour, 4 o'clock or 4 by the clock, meaning that four complete hours have passed since the beginning of the clock-round. When this is noon, and the hours afternoon hours, all is logical enough. We are obliged to call the beginning of the round the completion of the preceding; because though a clock may mark 0, as clocks used in observatories do, we cannot indicate nothing by a strike. Our ordinary habit, however, becomes illogical when we speak of morning hours and call them a.m. or ante-meridiem; for eight hours, for instance, before noon should mean what we call 4 o'clock in the morning or 4 a.m. To be logical, the morning or a.m. hours should diminish instead of increasing; but the usage cannot well be altered, and it is not likely that ordinary people will ever adopt the astronomer's plan and count the whole day through twenty-four hours, even if astronomers try to conciliate them by dropping their practice of beginning the day at noon. For this there is now much less reason than there was in early days of the science, when it was thought desirable to keep a whole night's observations under one date; for modern astronomers make a considerable number of observations in daylight and during the day hours.

W. T. Lynn.

POPULAR GEOLOGY.[1]

Some fifteen years ago, if a book had been published under the title of "The Scenery of Switzerland," the reading public might have expected glowing descriptions of the magnificent mountains, the wild waterfalls, the quaint châlets, the dangerous passes and precipices of that wonderful Alpine rampart of Switzerland

> "Which serves it in the office of a wall,
> Or as a moat defensive to a house,
> Against the envy of less happier lands."

And it would have been somewhat startled on opening the book to find the first chapter dealing with the "Geology of Switzerland," and bristling with a supply of technical terms seldom to be found outside a geological text-book. Nevertheless, that is how Sir John Lubbock's new book opens, and the title is accordingly somewhat qualified on the inner fly-leaf, where it reads in full, "The Scenery of Switzerland and the Causes to which it is due."

We have already had the æsthetic aspect of the Alps presented to us by such writers as Symonds, Ruskin, and Leslie Stephen; the mountaineering aspect by such famous climbers as Whymper, Freshfield, and Conway; the scientific aspect by Forbes, Tyndall, Bonney and others; and now Sir John Lubbock seeks to combine the æsthetic and the scientific aspects. It may be said at once that the book supplies to the cultured tourist a want which has been felt more and more for some years. Years during which Dr. Lunn's inexpensive tours have brought a journey to Switzerland within the reach of modest incomes, and when popular lectures on physical and geological subjects have attracted ever-increasing interest. Besides, these are *fin de siècle* days, when the mere sensuous enjoyment of the beauties of Swiss mountains is not enough to gratify the tourist! He wants to surmount their difficulties, either physically by climbing their summits, or mentally by mastering the secrets of their structure—to *come* and *see*—yes, but also to *conquer* the grandeur of the Alps!

The intellectual conquest of the Alps, however, is not yet completed by geology, and this is the very fact which has restrained many of the veteran geologists abroad from attempting a popular book on the subject. Prof. Fraas published in 1892 a useful book called "Scenerie der Alpen," which erred in being too geological for the ordinary tourist. In 1894, the Committee of the International Geological Congress published a special "Livret-Guide" of Switzerland, wherein pedestrian tours are planned and described geologically by the best Swiss authorities on the various areas of the Alps. With these exceptions, Sir John Lubbock entered an open field, and has done so with considerable success.

The book numbers 473 pages, arranged in twenty-five chapters. About two-thirds of it are devoted to the *geological* causes, while one-third discusses the *physical* causes which have moulded the surface features of Switzerland.

It is perhaps rather unfortunate that the book begins with three such difficult chapters as those entitled "The Geology of Switzerland," "Origin of Mountains," and "The Mountains of Switzerland." In the opening pages the reader finds himself perforce initiated into the involved question of the origin of gneiss.

> "The foliation of Gneiss is probably of two kinds: the one due to pressure, crushing, and shearing of an original igneous rock such as Granite, the other to original segregation-structure" (p. 3).

A sentence like this cannot but be a stumbling-block to the ordinary reader. Granite, Serpentine, the Crystalline Schists, and the successive geological periods from Carboniferous to Miocene and Glacial time are briefly dealt with. The second chapter contrasts "Table Mountains" with "Folded Mountains," and demonstrates that the Swiss mountains belong to the latter class, having been "thrown into folds by lateral pressure." Geological terms—such as outcrop, dip, and strike; fold, fault, and fold-fault; anticline, syncline, slickenside, and cleavage are explained; various examples are also given of the dynamo-metamorphic changes induced in rocks. Attention is directed in the third chapter to the fact that the main longitudinal valleys (*e.g.* the Rhone-Rhine valley which cuts through Switzerland in the direction of the main axis, S.W.-N.E.) occupy the troughs of the mountain-folds, whereas the transverse valleys (*e.g.* the Reuss and Ticino in N.W.-S.E. direction) are independent of the folds, being "entirely due to erosion." Denudation of the surface is discussed, and the geological proofs are given of the former presence of an arch of sedimentary strata above the crystalline rocks of the central chain of the Alps. Three well-known geological sections illustrate the text—Schmidt's section from the Rhone valley at Viesch to the Averser valley in the Engadine, Favre's "Mont Blanc" section, and Heim's "Windgälle and St. Gothard" section. A computation "gives 4500 metres or, say, 14,000 feet, which erosion and denudation have stripped from the summits of the mountains!" (p. 66).

There follows a lighter series of six chapters on glaciers, valleys, rivers, and lakes. The physics of ice and ice-movement, and the characteristic features of glaciers are carefully described. Evidences of the "Former Extension of Glaciers" are considered, and abundant examples quoted of the influence which ancient moraines had in diverting the courses of rivers and damming up lakes. The chapter on "Valleys" leads us into some confusion of ideas. A "fault valley" is said to be "comparatively rare" (p. 143). The writer repeats the principle mentioned above, that cross-valleys are valleys of erosion, while longitudinal valleys are of geotectonic origin. But he then asks himself the question, "Why should the rivers, after running for a certain distance in the direction of the main axis, so often break away into cross valleys?" (p. 148). "Three possible explanations," suggested by Prof. Bonney, are given, and then the following passage occurs:—

> "Under these circumstances I have ventured to make the following suggestion. If the elevation of the Swiss mountains

[1] "The Scenery of Switzerland, and the Causes to which it is due." By the Right Hon. Sir John Lubbock, Bart., M.P., F.R.S., &c. Pp. 473. (London: Macmillan and Co., Ltd., 1896.)

be due to cooling and contraction leading to subsidence as suggested in page 34, it is evident, though, so far as I am aware, this has not hitherto been pointed out, that, as already suggested, the compression and consequent folding of the strata (Fig. 43) would not be in the direction of A B only, but also at right angles to it, in the direction A C, though the amount of folding

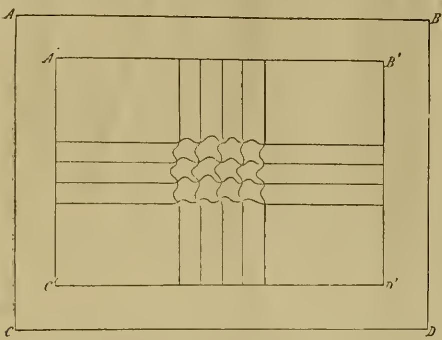


Fig. 43.—Diagram in illustration of mountain structure.

might be much greater in one direction than in the other. Thus in the case of Switzerland, as the main folds run S.W. and N.E., the subsidiary ones would be N.W. and S.E. If these considerations are correct it follows that, though the main valleys of Switzerland have been immensely deepened and widened by rivers, their original cause was determined by tectonic causes" (pp. 149, 150).

Thus the chief distinction previously made by the writer between longitudinal and transverse valleys is finally annihilated by his own suggestion that both may have had their primal cause in tectonic movements! But this idea finds by no means its first exponent in Sir John Lubbock. It is perfectly familiar throughout the writings of Austrian and German geologists. Take the following passage, which I translate from Rothpletz :—

"*As the youngest expression of the mountain-forming forces*, these (the transverse faults) have had a specially important influence on the present topography of the mountains, the direction of the flowing waters, and the origin of lake-basins. It is to them above all that the longitudinal synclinal folds of the Alps owe the outflow of their waters by transverse valleys; and the length of high ridges of rocks has been determined by them." ("Ein geolog. Querschnitt durch die Ost-Alpen." Stuttgart, 1894, p. 190.)

The stratigraphical facts observed by these geologists somewhat modify the theoretic suggestion of Sir John Lubbock. They prove that the transverse lines of weakness, whether of simultaneous origin or not with the longitudinal folding, were planes of movement long after the longitudinal folds had *ceased* to move, *i.e.* had become in technical language "dead" folds. *It is this relative youth of the transverse faults which has made them so often revolutionisers of Alpine drainage.* We would certainly have expected to have this important matter looked into by Sir John Lubbock, especially as he has devoted considerable space to minute matters of drainage in the three succeeding chapters on the "Action of Rivers," their "Direction," and "The Lakes."

With regard to the vexed question of the excavation of the lake-basins by glaciers, Sir John Lubbock states that "there are strong reasons against regarding glaciers as the main agents in the formation of the great Swiss and Italian lakes" (p. 210). The general reader may learn much from the chapter on "Lakes."

A very important subject is then introduced in Chapter x.—"The Influence of the Strata upon Scenery." If I may prophesy, this is the "coming" theme in popular geology. Combining as it does the interest of beauty of form with that of varied natural phenomena, it appeals alike to artist or tourist, geographer or petrographer, physicist, chemist, or geologist. This, I repeat, is at once the grandest, the most striking, and the most popular department of the Science of Scenery; and, what is more, the student of it would rightly choose Switzerland for his field of study in preference to any other country in Europe! Yet Sir John Lubbock has devoted only one chapter of twenty pages to this subject, and has treated it in a meagre, perfunctory manner. Only one sketch-section by Baltzer illustrates this extensive subject. The reader who brings enthusiasm to the book, and has Alpine pictures in his eye, will stir life into the bare facts, but the reader who has not will fail to be impressed.

All the subsequent chapters from xi. to xxv. are geological in their bearing, and take up the districts of Switzerland in turn. The geology of the Jura mountains is sketched in simple, clear style in Chapter xi. The Miocene and Glacial deposits of the "Central Plain" of Switzerland are described in Chapter xii. The next, entitled "The Outer Alps," is one of the best in the book. It runs easily along and describes, amongst other things, the geology of the ever-fascinating Rigi and its proud rival Mount Pilatus. One almost regrets that the chapter should be brought to its close in the cloud of controversy which overhangs the history of the "Klippen." The chapter on "Central Massives" is rather overladen with the opinions of many geologists, but concludes by regarding the Central Massives (1) "as an integral part of the general Alpine system, not as independent centres of upheaval; and (2) as complex systems of compressed folds" (p. 307).

Chapter xv., "The Lake of Geneva" is, like Chapter x., a sacrifice to science—useful, instructive, practical, but written with a marked economy of the imagination. Surely the most prosaic Englishman who has seen the view of the mountains from the northern side of the lake must remember it all his days, and feel the very words "Lake of Geneva" act like a charm upon him. This chapter in the "Scenery of Switzerland" commences as follows :—

"The Lake of Geneva is 45 miles in length, and about 10 in breadth. It is 375 metres above the sea, or 309 in depth.

"The bottom, moreover, is covered by subsequent deposits to an unknown depth, so that originally it was probably below, perhaps much below, the sea-level. Indeed, if the slopes of the mountains at Meillerie and Vevey (see Fig. 100) are continued under the bed of the lake, the alluvium must have a thickness of no less than 600–800 metres, which would make it 200–400 metres below the sea-level. The actual outlet at Geneva is in superficial débris, but the river comes upon solid rock at Vernier, 1197 feet above the sea-level, 33 feet therefore below the surface-level of the lake, and 951 above the bottom. It is, therefore, a true rock basin" (p. 308).

The same conclusion is arrived at in the same matter-of-fact way about other lakes, *e.g.* Lake of Neuchâtel (p. 259), Lake of Constance (p. 414). There are some graceful touches however :—

"The country about Vevey and Montreux is the Riviera of Switzerland. It is lovely now, but what must it have been before the monotonous terraces of the vineyards and the endless rows of vine bushes replaced the ancient forests of chestnut, birch, and beech; and the picturesque Swiss châlets were extinguished by whitewashed villas and gigantic hotels" (p. 310).

"The Massif of Mont Blanc," Chapter xvi., again falls distinctly short of the sublimity of the subject. Is it so necessary to begin with exact figures?

"'The Massif of Mont Blanc' is elliptical in outline, about 30 miles in length, and 10 in breadth, extending from S.W. to N.E. from the Col de Bonhomme, across the Valais at Martigny to the Dents de Morcles; the extreme N.E. portion being severed from the rest by the Rhone" (p. 322).

Again, why give the reader so little of Sir John Lubbock, and so much of other authors? De Saussure and Favre may indeed have "made" the geology of Mont Blanc, but why these long French quotations from their writings? Does the Pavillon de Bellevue stand in need of a testimonial to its beauty from any French writer, even Favre? (p. 327). A graver objection to Sir John Lubbock's treatment of the Mont Blanc massif is the inadequate account of its geotectonic relations. It is impossible to satisfactorily explain the "causes to which Mont Blanc is due," without setting forth its relations to the fold "trough" of the Briançonnais and the broken western end of the Valais "crest" of mountains. It is, indeed, the greatest blemish in Sir John Lubbock's book that he nowhere gives a geological insight into the structure of the Monte Rosa massif of mountains from the Simplon Pass to the St. Bernard. Yet this area is the Swiss frontier, whereas the Mont Blanc massif is almost wholly French and Italian. However fully, then, the succeeding chapter on "The Valais" treats the Rhone Valley, it misses its mark with regard to the mountains. The few notes on Zermatt and the Matterhorn, on p. 357, are quite insufficient.

The Bernese Oberland is more deftly handled than Mont Blanc. The intricacies of the overfold of gneiss are explained, and there are no fewer than six geological sections from Fellenberg and Baltzer to illustrate the fourteen pages. The Rhone, Upper Aar, Reuss, Ticino, and Rhine valleys are treated much after the fashion of the Swiss "Livret-Guide" referred to above, although without its daily itinerary. In these chapters we are made to feel that the author has himself gone over every step of the ground, but he follows the "Livret-Guide" too apparently in his geology. "Zürich and Glarus"—the title of Chapter xx.—gives an account of the variation in the movement of the old glacier which once filled the Lake of Zürich. The Glarus Mountains are described in accordance with Heim's well-known works. Chapter xxiv. on the Engadine is short. It explains the shifting northward of the watershed of the Alps, and the consequent formation of the line of lakes. The rocks of the Bernina, Julier, and Baselgia, are also indicated.

There are 154 illustrations in the book. Almost all are of the nature of geological sections or diagrams, 123 being reproductions from the works, mostly of Swiss geologists, and a few from English authors. The remainder are simple diagrams—with the exception of familiar photographs of the Rhone glacier, the Grimsel, and the valley of Chamonix; a successful photograph of the rock-fold at the "Cascade of Arpenaz," and another of a "Scratched Pebble" from the moraine at Zürich. Two figures specially deserve to be noted, Figs. 49 and 50, the front and side view of a river cone, as they, along with one or two drawings from Heim ("Bay of Uri," Fig. 141, and "Volcanic Group of the Hohgau," Fig. 138), and from Baltzer ("View near the Grimsel," Fig. 37, and "View of the Jungfrau," Fig. 124), are the only illustrations which present to the eye of the reader scenic effects in combination with geological or physical truths. Like the text of the book, the illustrations are too technical for a thoroughly popular book on "Scenery." On the other hand, if the book lacks in imagination and style, it is not wanting in valuable and trustworthy facts, and these may be enough for the utilitarian mind.

A standard work amongst us already shows what can be made of the "Scenery" of a country in the hands of a geologist who is gifted with an artist's feeling for nature, and is a master of style. I refer to Sir Archibald Geikie's "Scenery of Scotland." Without this, we might have demanded less from Sir John Lubbock in his "Scenery of Switzerland." As it is, he has conferred a boon on the travelling English public, and broken new ground in the literature of the Swiss Alps.

MARIA M. OGILVIE.

THE TOTAL ECLIPSE OF THE SUN.[1]

III.

TRONDHJEM, *August* 14.

SINCE writing my last notes, the eclipse has come and gone, and we are homeward bound, rather depressed but satisfied that the *Volages* and ourselves had done our duty, and that it was Dame Nature alone who was to blame.

Although on the 8th the weather in the forenoon was very fine and promising, towards the latter part of the day a change set in, and dark clouds came up.

Captain King Hall, who came over from the ship in the afternoon, soon detected what was wrong; there were two currents, an easterly and a westerly one, contending for mastery. This elemental war was watched with anxiety for two or three hours, and at times the weather chances improved, but later rain set in, and we could only hope against hope. It rained during our dinner-hour in the tent, an excellent one lent us by the War Department, kept dry under foot by a tarpaulin, and a deep trench outside cut in the peat. Lieut. Martin, the navigating officer, to whose constant care many of the admirable arrangements on the island were due, who had not only taken charge of the integrator, but who has *ipsissma manu* put up all three of the discs,[2] remained on shore and did the honours.

A dim memory of the Latin grammar suggested champagne as an accompaniment of the well-cooked provender, for were we not bound on the morrow to face not only the *ingens æquor*, but, if all went well, something still more awe-inspiring.

Dinner over, the process of filling up all dark slides with the plates for the morrow was accomplished by Lieut. Martin, Mr. Fowler, and Dr. Lockyer, after which it was suggested that we should turn in early.

The Rev. E. J. Vaughan, my son, and I occupied one of the army tents, while Mr. Fowler and Lieut. Martin had their stretchers placed in Kiö Town Hall, as the 6-inch hut had been called. Our last survey of the weather was not one to raise our spirits to any great extent, but we were still buoyed up by the observed fact that, as a rule, the early mornings, looking eastward, were moderately clear.

As we expected the *Garonne*, on her return from Spitzbergen, to anchor near our island some time in the early morning, we had arranged with the guard to light a beacon fire directly she was sighted, to show them our whereabouts.

At 1.30 my son took it into his head to take a stroll around outside; his attention was first drawn to the beacon burning brightly on the hill, and the four marines in their lammy suits standing by the side of it. Looming up very black and large, close to our island, was the good ship *Garonne*, before her time. It was not long before we received two nocturnal visitors, Captain Harry and Mr. Müller, who had come off to see about the day's arrangements. The weather was anything but pleasant, and their return to the ship was heralded by a downfall of heavy rain.

At 4 a.m. the parties, led by Captain King Hall, began to arrive from the ship, the first thing they did on landing being to make cocoa and breakfast. Mr. Thomas, in charge of the chronometer, and the readers of the thermometers, were the first to take their stations, and for these at the time of first contact the work began with the sky almost entirely covered with clouds, with narrow

[1] Continued from page 421.

[2] It may be worth while to state that the eye-pointers used in connection with the discs were impromptu affairs made by the ship's carpenter, but they promised to work well. There must be fine adjustments, because it is not likely that the point to be occupied by the eye will be calculated to an inch. For these adjustments, then, we have first a horizontal bar, on which hangs a vertical piece of wood about ten inches long, free to slide. On this piece of wood slides up or down a piece of brass carrying a pointer marking the place of the eye; this is brought into position at the beginning of totality by the amanuensis.

breaks near the sun's place, and wider ones near the horizon, a condition of things which relieved Mr. Fowler from his spectroscopic determination of the beginning of the eclipse.

Gradually everybody fell into their stations; the sketchers went up the hill, but there was no need for them to carry out their instructions to shield their eyes by turning their backs to the sun.

There had been no sun to adjust the siderostat, so it was clear that the 9-inch prismatic camera would in all probability not be employed. Still Dr. W. Lockyer stood by at the mirror to make final adjustments.

A few minutes before totality, the delicate crescent was seen dimly through one of the breaks. I watched it in the $3\frac{3}{4}$-inch for a minute or two, but the clouds closed up before the commencement. I gave it a little time, and then gave the signal, "Go," in order especially to start the 6-inch prismatic camera, as the important ten-

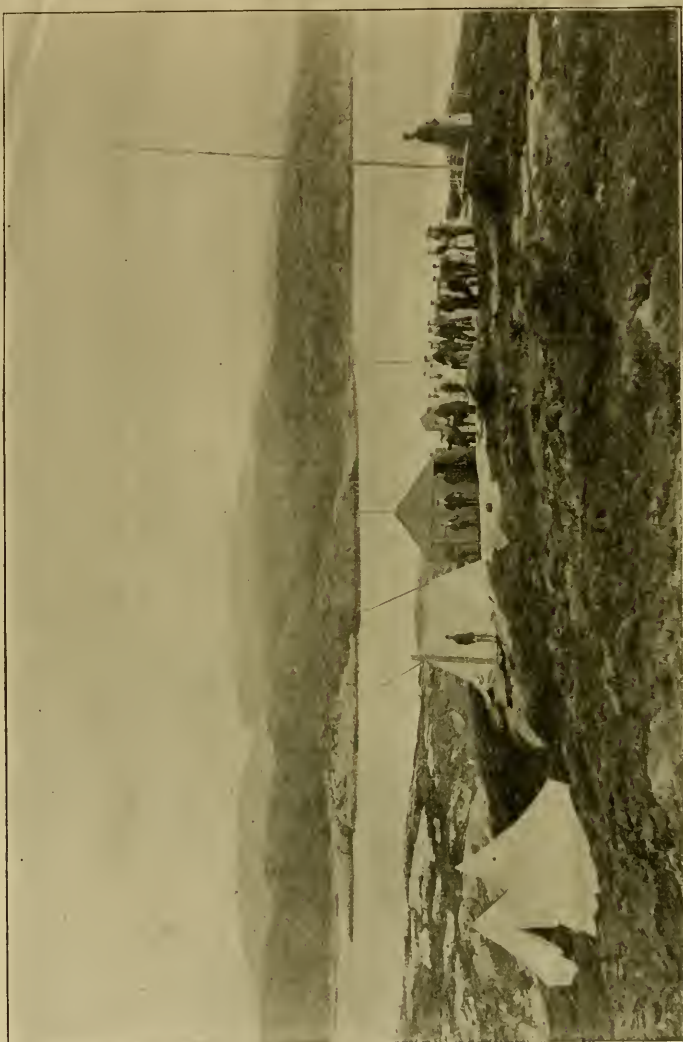


FIG. 9.—The Camp on Kiö Island, showing the Fiord and the Island and Land to the eastward.

seconds-before-totality-signal could not be given in the way agreed upon. All the photographic work, with the exception of the 9-inch, then went on as if the eclipsed sun were visible. The actual commencement of totality occurred shortly afterwards, the swoop of the shadow being almost felt. This instant was noted by Mr. Thomas amid a cry for lamps, especially from the time-keepers and some of the observers in the huts.

The time of the end of the eclipsed eclipse was also noted by Mr. Thomas, and the affair was over for most of us, although the colour observers and the meteorologists continued their notes till the fourth contact.

FIG. 10.—The Eclipse Observers. Photograph taken by Mr. Fowler immediately the Eclipse was over.

And then an unexpected thing happened. Captain King Hall called his men together, and, in a few admirably chosen words, expressed to me the regret of the *Volages* that such an important attempt to advance knowledge

had been frustrated. In reply, I told him that I thought an almost more important thing than the observation of a single eclipse had been accomplished. He had demonstrated that with the minimum of help, and that chiefly in the matter of instruments, such a skilled and enthusiastic ship's company as his could be formed in a week into one of the most tremendous engines of astronomical research that the world has ever seen; so that if the elements had been kind, all previous records of work at one station would have been beaten.

I added that I felt sure that the leaders of British science would thank him, his officers and men, for what they had done in aid of science when it came to be known, and further, that the kindness which the eclipse party had received on board the *Volage* had inspired a gratitude which it was not easy to express in words.

The party subsequently fell in to be photographed by Lord Graham and Mr. Fowler; then away to the ship for breakfast, and a curtailed Church service.

The repacking of the instruments was begun after breakfast, as the *Volage* was to rejoin the squadron the next day. Under these circumstances the Town Hall was left standing for the benefit of the friendly Lapps whose island we had invaded, but who seemed rather to enjoy our doings than otherwise. Talking of the Lapps, it would be interesting to know the Lapp mythology and folk-lore concerning eclipses. Immediately after totality, or rather so soon as it was light enough to render the channel separating Kiö from the island to the eastward clearly visible, we saw a large boat full of Lapps firing a *feu de joie*. The fact may be chronicled. I was all the more struck by it, as it seemed to be possibly connected with the Eastern custom to light fires to frighten away Rahoo, whose swallowing of the sun causes the eclipse.

. 11.—The 6-inch Hut, show ng Mr. Fowler and his Assistants at drill.

It seemed quite certain that the parties at Vadsö had fared no better than ourselves, and this was confirmed by the news brought by the *Calypso's* steam cutter in the afternoon. This cutter subsequently conveyed my son and myself to the *Garonne*, meeting her about a mile outside Kiö, and while the island was being rapidly left astern, full particulars were told me of all the camps which many of my shipmates had visited after the eclipse.

It was at Hammerfest that we first had news of any success, and that at Bodö. I had heard that there was a strong party of German astronomers at this place, but one of the fortunate ones, who subsequently came on board, told me, to my great regret, that there were no fixed instruments there at all, and that the photographs of the corona were taken with a small camera of the ordinary make.

Since my return home, it has been rendered evident that in inflicting upon us at Kiö so great a disappointment, Dame Nature was not really cruel, but was pointing a moral, namely, that in attempting to obtain records of eclipses, no stone should be left unturned in occupying every coign of vantage, however inconvenient or unpromising.

Hence she allowed a grand success to be scored at Novaya Zemlya, which would not have had a British observer within hundreds of miles had it not been for the chapter of accidents and the public spirit of Sir George Baden-Powell, who took a party there in his yacht *Otaria*. In this party was Mr. Shackleton, one of the assistants in the Solar Physics Observatory, who did such good work during the eclipse of 1893 in Brazil, and who, as already stated in NATURE, was hurriedly equipped after the larger eclipse instruments had been sent off.

It is on his results that I wish here to say a few words. I am sorry to say he is too unwell to give an account himself of his doings, but I have gathered from an article in the *Yorkshire Daily Post* that the voyage itself was by no means uneventful.

He left home on July 7, and joined the *Otaria* at Hammerfest, whence, after touching at Vardö, the party sailed for Novaya Zemlya, making for the Samoyede settlement of Karmakul, in the southern island. The intention was, after meeting some Russian astronomers, and obtaining information as to the navigation, to take up a point of observation some ten miles further south, in Gooseland, on the central line of the shadow-path. Although the party had not a very good chart—no trustworthy ones of these remote regions being published—they got into the bay on Bank Holiday Monday, and were going at a good speed—about ten knots—when the vessel gave three bounds and stood still, heeling over on her side.

The account continues:—

"Everybody hung on to something, for it was impossible to stand. Fortunately, however, the reef was only of soft rock, and it did little damage to the ship; only for four days we remained like that, about a mile away from the nearest land. We could not walk except by holding on to ropes, and had to get our meals on our knees or on the floor with cushions. After four days' hard work the sailors nearly emptied her, and pumped out all the drinking-water, and then at a high tide pulled her off."

It appears that

"The mishap arose from a little want of familiarity with the Russian cartography of these parts, which is naturally better than ours. It turned out that the soundings of the deeper portions were, so to say, in fathoms and the shallower in feet. A few of the deeper soundings having been verified by the lead, the rest were taken for granted, with the unpleasant result already detailed."

Still, in spite of this mishap, everybody working with a will, things were more or less ship-shape on the eclipse morning. There had not been many opportunities of adjustment, but, not unmindful of possibilities, I had taken the precaution of having every portion of the more important instruments adjusted, and each adjustment plainly marked before I sent it off.

Mr. Shackleton obtained twenty-one photographs with the prismatic camera, thirteen during totality, and five of the corona. I have already enlarged and begun to discuss these photographs, and I have seen enough already to be able to say that in my opinion the results obtained are of the highest possible value. In fact, we may almost say that the long-talked-of "flash" has at last been photographed. This brings a test to apply to contending theories, and there will be a good deal to be written about it later on.

It is not too much to say that "the winter of our discontent" at Kiö is turned into "glorious summer" by the sun of Novaya Zemlya!

I must not forget to add that the photographs of the corona, though they are of much lower value from the theoretical point of view, will be very useful in enabling the change in the appearances of the corona from eclipse to eclipse in relation to the sun-spot period, to be chronicled.

The *Yorkshire Daily Post* states that Dr. Stone, who also accompanied Sir George Baden-Powell, has obtained some photographs of spectra.

I must be permitted one other extract from Mr. Shackleton's statement, as it indicates the success of Sir George Baden-Powell's cruise in another direction, and is interesting as an account by an eye-witness of a most interesting event.

"After the eclipse we were busy repacking and getting all on board again. Our intention had been to go to the northern island to see about the safety of some stores which had been left there for Dr. Nansen, but we found it prudent to make direct for Hammerfest. Some of the Russian astronomers were about to make the attempt to cross Novaya Zemlya by means of dogs and sledges. . . ."

"At Hammerfest, on our return, we heard that Dr. Nansen had arrived outside, and as the steamship *Thor* came in and dropped anchor alongside, the intrepid explorer recognised Sir George, whom he knew well, and halloed, 'Hallo, Baden-Powell, is that you? I did'nt expect to see you here.' Our cutter was out, and at once Sir George was rowed off to the *Thor*. Dr. Nansen returned with him immediately, to the disappointment of the Norwegians, who were playing their National Anthem, and making other demonstrations in his honour. This was on Tuesday, the 18th. Mrs. Nansen arrived by express steamer, and the Doctor was very anxious to see her again. When she arrived there was an affecting scene. The reunion proved too much for the feelings of the faithful wife, who fainted away, and did not recover consciousness for a considerable time. Then came redoubled rejoicings. The people of Hammerfest were too much delighted to leave their countryman much opportunity of private happiness, and made a feast in the public hall. Dr. Nansen was very anxious about the *Fram*, though he felt quite confident that she would be coming in. 'It is only,' said he, 'a question of a week or two,' but at the same time he appeared disappointed that she had not preceded him. Our yacht took Nansen on to Tromsö, but I left her at Hammerfest to return by express steamer. The *Fram*, as you will have seen from the papers, turned in near Tromsö. When our steamer reached Tromsö the people there were very much disappointed that we had not brought Nansen back with us. At Bodö we learnt of the receipt of a telegram announcing that the *Fram* had returned, but at first were inclined to treat the news as a joke. It, however, turned out to be correct; so for the second time we hoisted all our flags and bunting in honour of the Arctic exploring party."

Fig. 12.—Lieut. Martin, R.N., setting up a disc.

Mr. Shackleton is loud in his acknowledgment of the kindness shown him by Sir George and Lady Baden-Powell, and they may, I think, rest assured that the scientific public of these islands, to speak of no wider territory, are grateful to them for their efforts in the cause of science. J. Norman Lockyer.

NOTES.

The Sanitary Institute has been holding its Congress at Newcastle-on-Tyne during the past week, and has got through a great deal of work. The Congress was opened on September 2 by the Duke of Cambridge, as President of the Sanitary Institute, after which the inaugural address was delivered by Earl Percy, the President of the Congress.

The steam-yacht *Windward*, with four members of Mr. Jackson's expedition on board, arrived in the Thames on Saturday. The yacht was the bearer of a voluminous mail from the leader of the expedition, some valuable maps, and several cases of scientific collections. The returned explorers, as was to be

expected, had a narrative of the highest interest to relate; but as this has been very fully reported by the daily press, we need do no more than report that Mr. Jackson has been able to confirm some of the more important discoveries of last year, and to produce a map of Franz Josef Land, which for the first time lays down with approximate accuracy its geographical outline, and at the same time entirely alters the previous records. Valuable botanical discoveries are reported to have been made, and numerous photographs taken of birds and beasts of the country in their native habitat and under ordinary conditions.

AFTER an absence of rather more than two years, Dr. Forsyth Major has returned to England from his scientific mission to Madagascar. His task was a very difficult one to perform, in consequence of the unsettled state of the country at the time of his visit, but Dr. Major seems to have succeeded in doing some solid scientific work. The explorer's collections have been deposited in the Natural History Museum, and include many specimens of *Æpyornis* bones from the marshes at Sirabé, and an extensive series of skins representing the recent fauna of the island. A fine collection of specimens of the flora of Madagascar, including four orchids reported to be new to science, has also been made.

DR. W. R. GOWERS will deliver the Bradshaw Lecture at the Royal College of Physicians on November 5. The title of the lecture will be "Subjective Sensations of Sound." The Lumleian lecturer for next year is to be Dr. Bastian, and Dr. Luff will be the Gulstonian lecturer. Prof. Sidney Martin is to deliver the Croonian Lecture in 1898.

ACCORDING to information brought by the steamer *Quiraing*, a severe earthquake (the severest since 1784, it is said) occurred in Iceland on the evening of August 26 and the following morning. Many farms at Hrepp, on the east coast of Iceland, two churches, and nearly all the farms in Hollum, Laudi, Kangaullum, Hollkrapp and Fgolshlid were destroyed, and sheep and cattle killed. Reykjavik, Bargarfjord and Hrulafjord suffered slightly. No lives seem to have been lost. The centre of the disturbance was apparently Hecla, where an eruption appeared imminent.

A REUTER telegram of September 2, from Yokohama, reported a disastrous earthquake in the north-east provinces of Japan on the evening of August 31. The town of Rokugo was entirely destroyed, and other towns were severely damaged. Many lives were lost. On the same day extensive damage was done in the southern parts of Japan by a typhoon.

THE death is announced of Mr. R. W. R. Birch, a hydraulic and sanitary engineer of repute. Mr. Birch had been for many years a member of the Council of the Sanitary Institute, and of the Royal Meteorological Society.

NEWS has come from Annemasse (Haute Savoie) of the death of M. Henri Aimé Résal, the mining engineer. M. Résal, who was the author of numerous books on mining mechanics, was a member of the Academy of Sciences, editor of the *Journal des Mathématiques Pures et Appliquées*, and President of the Société Mathématique de France. He was born in 1828.

THE death is recorded, at the age of seventy-three, of Prof. Egli, the geographer, who is perhaps best known for the "Nomina Geographica" which he edited.

THE new Gatty Marine Laboratory at St. Andrews, intended to replace the wooden structure in which Prof. McIntosh has worked for the past ten years, is to be formally opened on October 8. Its more noticeable features will be a tank-room 30 feet square, and a research-room of the same dimensions. The latter is being fitted to accommodate six workers.

THE fungus foray of the Yorkshire Naturalists' Union, which has now been for several years an annual event, is to take place this year at Selby, from which as a centre excursions are to be made to various woods in the East and West Ridings, on September 19, 20, 21, and 22; the members of the party meeting each evening at the "Londesborough Arms," to compare notes and arrange the fungi gathered. On Monday evening, September 21, a conference will be held, at which papers will be read by Rev. Canon Du Port, Mr. George Massee, Mr. Carleton Rea, and Mr. Harold Wager, and in illustration of their remarks a lantern will be provided by Mr. W. Norwood Cheesman. Mr. A. Clarke will exhibit a number of stereoscopic photographs of fungi, and microscopes will also be provided. Mycologists who may wish to attend will be heartily welcomed, and circulars will be sent on application to Mr. W. Denison Roebuck, Sunnybank, Leeds, or to Mr. W. Norwood Cheesman, The Crescent, Selby.

A BLOCK of granite bearing the following inscription has, says the *Academy*, been recently placed on the southern shore of the Lake of Sils in the Engadine:—"In memory of the illustrious English writer and naturalist, Thomas Henry Huxley, who spent many summers at the Kursaal Hotel, Maloja."

It is announced that the Royal Society of Canada has resolved to commemorate the five-hundredth anniversary of the first landing of Cabot in North America by holding a meeting at Halifax from June 20 to 26 of next year, and to erect, at a cost of not less than £200, a monument at Sydney in Cape Breton.

NOTICE is given in the current number of the *Journal of the Society of Arts* of two prizes offered by the Society. One is the "Fothergill" of £25 and a silver medal, for a paper on "the best means of effectually preventing the leakage of current to earth in electrical installations from generating heat and setting buildings on fire." The paper should consist of about eight thousand words, and be written with a view to being read and discussed at an ordinary meeting of the Society. Papers submitted for the prize must reach the Secretary by October 1 of this year. Each paper must be type-written, and bear a motto, the name of the writer being enclosed in a sealed envelope with a similar motto. The other prize announced is a gold medal and the sum of £20, and is to be bestowed, under the terms of the Benjamin Shaw Trust, "for any discovery, invention, or newly-devised method for obviating or materially diminishing any risk to life, limb, or health, incidental to any industrial occupation, and not previously capable of being so obviated or diminished by any known and practically available means." Descriptions of the inventions of intending competitors must reach the Secretary of the Society of Arts not later than December 31, 1896.

THE Sanitary Institute has just issued a list of its twenty-second course of lectures and demonstrations for sanitary officers and students. The course, which is to be commenced on Monday, September 28, by a lecture, by Mr. Wynter Blyth, on "The Education, Status, and Emoluments of Sanitary Inspectors," has been arranged for the special instruction of those desirous of obtaining knowledge of the duties of sanitary officers, and of others desirous of obtaining a practical knowledge of sanitary requirements and regulations. The lectures will be delivered at the Sanitary Institute, London, and the introductory lecture is to be free.

CAPTAIN ROBERTSON, of the Dundee whaling vessel *Active*, which has just returned from a voyage to the Arctic regions, has, says the *Times*, forwarded to Mr. Dickson, of Oxford, the result of certain observations made, at the request of the latter, during the cruise, together with samples of the water through which the *Active* sailed. The observations were taken with a view to

ascertaining the distribution of food fishes in relation to their physical surroundings; and the samples of water brought home number 130, taken from the sea each day at noon, the surface temperature and other particulars having been noted. It is understood that the results of the inquiries will be communicated to an international congress of men of science interested in this and kindred questions.

AN account of an interesting plant which has the apparent property of turning its leaves in a north and south direction, thus behaving like the needle of a compass, is given in *Garden and Forest*. Mr. E. J. Hill, of Chicago, who seems to have been investigating it, gives the name of the plant as *Silphium laciniatum*, and says that the *Silphium terebinthinaceum* is affected in the same way, seventy-five per cent. of the latter orienting themselves in the manner mentioned above. The tendency to orientation seems to be a function of the ages of the leaves in question, the younger ones being said to point more accurately north and south than those of greater age, the latter falling off and therefore supplying an insufficient amount of evidence. It is mentioned that Sir Joseph Hooker remarked the uses which might be made of the peculiarity of this plant; it is stated, also, that he was able when travelling to note perfectly the change in direction of the train by observing the general appearance of these plants which were scattered over the plain.

IN consequence of the great number of earth movements that occur in Turkey and on the boundary of the Ottoman Empire, the Meteorological Observatory of Constantinople had been charged to make a study of them. The first year's observations were begun on January 1, 1895 and the director, Dr. Agamennone, has given in the *Bulletin* some details of the results obtained. The mean number of movements per day amounted to over two, the total number amounting to 753, and out of these 400 had been observed in Turkey, 236 in Greece, and 56 in Bulgaria. Tabulating these movements in order of their magnitude it is shown that the small ones are the most frequent, amounting to 519. The moderate ones are 225 in number, while the remaining 9 have resulted in large calamities. The importance of this new branch will be demonstrated when the observations extend over a larger period of time, as certain marked indications, which appear to precede large disturbances, will be more fully studied. In this way warnings may be eventually given of disturbances likely to do damage.

The current number of *Kosmos* (No. 606) gives the results obtained by Mr. Eginitis of the velocity of the earth-wave during the earthquake at Constantinople. Employing the method of Dutton and Hayden, he finds that the depth of the centre of disturbance was 34 kilometres, a distance not very different from that obtained by Mr. Lecomte. The velocity of the wave he found to be between 3 and 3·6 kilometres per second, a value equal to that found for the progress of the wave movement in the last earthquake at Locride. Mr. Eginitis reminds us of the seismic period which two years ago affected the eastern part of the Mediterranean, Zante, Thebes, Locride, Constantinople, and Sicily, without mentioning some of the minor movements in Europe and Asia. These countries lie nearly in a straight line.

IN the *Comptes rendus* for August 17, M. Berthelot gives an interesting account of some recent explorations of the copper mines of Sinai, the most ancient workings mentioned in history. These mines were worked by the Egyptians from the time of the third dynasty (about 5000 B.C.), and were abandoned about 3000 years ago owing to the poorness of the deposits and their distance from Egypt proper. The ores consist of turquoises, containing about 3·3 per cent. of oxide of copper, and sandstone impregnated with carbonate and hydrosilicate of copper, the metal forming two or three per cent. of the rock. The minerals were carefully sorted and fused with oxide of iron and carbonate of lime in crucibles made of quartzose sand cemented by clay. The furnaces were built of sandstone, and the fuel used was wood. Both fuel and carbonate of lime must have been brought from some distance. Some of the slags consist largely of $2FeO.SiO_2$, with the addition of crystals of magnetite; others are less basic, and contain lime. It is remarkable that the existing fragments of furnaces and crucibles, the slags and the scoriæ contain the same products, and show the same characteristics as those in modern smelting-works, and that the general method of extracting the metal differed little from that still employed in the treatment of similar ores. At a time when weapons of wood and stone were used by the Egyptians the copper must have been highly prized by them; moreover, the hand-labour of slaves cost little. The continuous working of such poor deposits need not therefore occasion surprise.

THE Vienna correspondent of the *Times* states that an interesting report of its first year's work has just been issued by the Austrian State Institute for the preparation of anti-toxin serum. Of 1100 cases of diphtheria treated with the serum, 970 recovered, a very favourable result compared with the previous mortality. When the remedy was applied on the first and second day of the illness, the percentage of deaths was only 6·7. After the third day, however, the mortality reached 19 per cent., rising to 33 per cent. after the sixth day. Of 318 cases of preventive inoculation only twenty were attacked by the disease, mostly in a mild form, and all recovered.

THE winter session of the medical schools and colleges in the United Kingdom will open at the beginning of next month, and in connection with many of the institutions an address or a lecture will be delivered by a prominent medical man. We glean from the *British Medical Journal* the following information respecting the opening arrangements of most of the schools:—St. Bartholomew's Hospital College session will begin on October 1, when (or on the succeeding day) a dinner of past students will be held in the great hall of the hospital. Charing Cross Medical School will re-open on October 5, on which day, at 4 p.m., Prof. Michael Foster will, as has already been stated in these columns, deliver the first Huxley lecture on "Recent Advances in Science, and their bearing on Medicine and Surgery." At the opening of the St. George's Hospital School, on October 1, an address may be expected from Mr. W. Adams Frost. In the evening of that day the annual dinner of past and present students will take place at the Hôtel Métropole. The winter session of Guy's Hospital Medical School will begin on October 1. The biennial festival dinner of the school will be held the same evening at the Hotel Cecil. The London Hospital Medical College will re-open on October 1, and in the evening the annual dinner will take place in the college library. An introductory address will be given at the opening of the session of St. Mary's Hospital School, on October 1, by Mr. Morton Smale. The school's annual dinner will be held at the Holborn Restaurant on the same day. At the Middlesex Hospital School Dr. W. Essex Wynter will, on October 1, deliver an address, and past and present students and others will meet for dinner at the Café Royal in the evening. At the school in connection with St. Thomas's Hospital the prizes will, on October 2, be distributed by the Lord Justice Lindley, and in the evening former and present students will dine together at the Whitehall Rooms. The session of the Faculty of Medicine of University College will commence on October 1, when Prof. Sidney Martin may be expected to deliver an introductory address. Past and present students will meet for dinner in the evening at the Hotel Cecil. Dr. Wills will deliver an address at the re-opening of the Westminster Hospital Medical School, and the prizes will be subsequently delivered by Archdeacon Furze. The annual

dinner will take place in the evening of that day at the Westminster Palace Hotel. Mr. Jonathan Hutchinson will, it is announced, deliver an introductory address at the opening of the session at the Owens College on October 2. At University College, Liverpool, the session will commence on October 1, on which date Sir William O. Priestley will distribute the prizes. Mr. Victor Horsley has consented to open the session of the Medical Department of the Yorkshire College, on October 1, with an introductory address; he will also distribute the prizes. The winter session of the Queen's Faculty of Medicine, Mason College, will commence on October 1; so also will the sessions of the College of Medicine, University of Durham, and the Sheffield School of Medicine. At Durham, the scholarships and prizes will be distributed by the Bishop of Newcastle; and at Sheffield, Sir Henry Littlejohn will deliver an introductory address.

The current issues of the *Lancet* and the *British Medical Journal* are almost wholly devoted to information likely to be of service to those who are students, or who are about to become students, in one or other of the medical schools of this country. The *Chemist and Druggist* for September 5 contains articles and details specially written for the future chemist and druggist.

Mr. Edgar Thurston, Superintendent of the Government Museum, Madras, has, with the assistance of Mr. T. N. Mukerji, prepared a copious index to the valuable "Dictionary of the Economic Products of India," by Dr. G. Watt, a review of which appeared in our columns of November 1, 1894. Those who have to refer from time to time to Dr. Watt's great work will, we have no doubt, be grateful to the compilers of the present volume. It is issued from the office of the Superintendent of Government Printing, Calcutta.

The Sub-Committee charged with the reception of the British Association have done a very excellent work in compiling an interesting handbook to Liverpool and its neighbourhood, entitled "A Scientific Handbook to Liverpool," a work which, though mainly intended for the benefit of those attending the meeting, will possess a considerable value after the meeting is over. We do not know to whom the happy idea originally occurred, but are probably not far wrong in attributing it to Prof. Herdman, who certainly undertook the duties of editing and general arrangement, and has carried them out very happily. The various authors by whom he has been assisted are not only peculiarly qualified to deal with the subjects severally treated, but each has apparently been solicitous to collect a mass of details which will save any one interested in a similar research a great amount of time and trouble. We have only space to give the bare titles of the several chapters; but this is of the less consequence, as the little book, it may be hoped, will find its way into the hands of all intending visitors. Mr. W. H. Picton, able to draw on the work and research of his father, deals with history and antiquities; while Mr. G. H. Morton is responsible for the notes on the geology of the district. Dr. Forbes, of the Liverpool Museum, treats of the vertebrate fauna; Prof. Herdman reserving to himself the marine fauna. Mr. W. E. Sharp and Mr. R. Brown share the entomological and botanical interests. Mr. Plummer gives statistics connected with the climate of Liverpool and Birkenhead; and Dr. Oliver Lodge contributes an article on the Mersey and its tides. The article on the Docks and the principal engineering features of the city is jointly produced by Prof. Hele-Shaw and Mr. Percy Boulnois, the city engineer; while Sir W. Forwood treats of the city's trade and commerce. The history of the chemical industries is entrusted to Dr. Kohn. This list of names amply justifies the remark that each section has been entrusted to the authority best qualified to deal with it. An appendix supplies some useful information concerning the Isle of Man, where it is proposed to hold a subsidiary meeting at the conclusion of the Liverpool meeting properly so called. Five maps are included in the book—a geological map of the district, a biological chart of the Irish Sea, a chart of Liverpool Bay, a geological map of the Isle of Man, and a chart of the sea round the southern extremity of the isle, including the biological station at Port Erin. Such a book cannot but add greatly to the interest of the meeting, and afford much valuable instruction not only to the members of the British Association, but also to the inhabitants of Liverpool, who must have often felt the want of such a handbook. It is issued for the British Association by Messrs. Philip, Liverpool.

In addition to the above-mentioned guide-book, the British Association has issued, also through Messrs. Philip, an "Excursion Guide Book," in which is to be found just the information likely to be of interest and use to those taking part in the numerous outings arranged; and being partly the work of leaders of the excursions, and under the editorship of one of the local secretaries of the meeting, its contents may be thoroughly depended upon.

The additions to the Zoological Society's Gardens during the past week include a Mona Monkey (*Cercopithecus mona*, ♀) from West Africa, presented by Mr. F. Wyville-Thomson; two Garnett's Galagos (*Galago garnetti*) from Mombassa, East Africa, presented by Rear-Admiral Rawson, C.B.; a Brown Capuchin (*Cebus fatuellus*, ♀) from Guiana, presented by Miss Cissie Wade; a Suricate (*Suricata tetradactyla*, ♀) from South Africa, presented by the Rev. Wilfred Fisher; an American Black Bear (*Ursus americanus*, ♂) from Vancouver Island, presented by Lieut. Bryan Godfrey Faussett, R.N.; a Llama (*Lama peruana*, ♂) from Peru, presented by the executors of the late Colonel J. T. North; a Moorish Tortoise (*Testudo mauritanica*), a Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mrs. Fraser; an Alligator (*Alligator mississippiensis*) from Florida, presented by Mr. Hugh Mytton; a Brown Capuchin (*Cebus fatuellus*, ♀), a —— Bell Bird (*Chasmorhynchus*, sp. inc.) from Guiana, three Painted Terrapins (*Clemmys picta*) from Nova Scotia, deposited; a Long-tailed Glossy Starling (*Lamprotornis æneus*), two Yellow-backed Whydah Birds (*Coliopasser macrurus*, ♂ ♀) from West Africa, purchased.

OUR ASTRONOMICAL COLUMN.

New Comet.—A telegram from Kiel announces the observation of Comet Giacobini on September 4 last, at 8h. 44m. Nice mean time. Its position was then R.A. = 17h. 10m. 30s., Declination = $-7°\ 29'$. The given movement per day is 1·8m. in R.A. and 0'·25 in declination, so that the comet should be looked for soon after sunset, the above position being about 22° due south of α Herculis, making also a very obtuse isosceles triangle with ζ and ν Ophiuchi. Another telegram gives particulars of a second observation of Comet Giacobini at Nice, on September 6, 8h. 26·5m. Its position as observed was R.A. = 17h. 14m. 16s.; Declination = $-7°\ 49'$. The comet is noted as very feeble.

Comet Brooks (1896).—A telegram received from Kiel announces the observation of this comet at Geneva on September 4, at 10h. 0m. It was then in R.A. = 13h. 30m.; Declination = $+55°\ 40'$. This gives a position admirably suited for observation, being about 2° due east of ζ Ursæ Majoris. The motion of the comet is eastward. Another observation of the comet has been made at Lick Observatory. Its position as seen there on September 6, at 11h. 56·5m., was R.A. = 13h. 51m. 44s.; Declination = $+55°\ 25'$. The motion per day is 6·5m. in R.A. and 36" in Declination, the general direction being easterly. No mention is made of the appearance of the comet.

Telegrams to "Astronomischen Nachrichten," No. 3376.—We gather the following information from the current number of the above journal. Prof. Holden, writing from Mount Hamilton, dated August 11, says: "A telegram just received from Schaeberle says that the sky was wholly clouded at his eclipse station in Japan." Mr. Lowell telegraphs from his observatory at Arizona on August 31: "Companion Sirius re-discovered by Dr. See. Angle 219°. Distance 5"·9." Prof.

Pickering telegraphs, also on September 1, from Cambridge, Mass., to the following effect: "Bailey at Arequipa finds μ' Scorpii spectroscopic binary. Period 35h."

THE PLEIADES.—Some time ago, we gave an account of several legends and myths connected with that most interesting cluster of stars, the Pleiades. These myths were, for the most part, gathered from an article which appeared in *Globus* (Bd. 64, p. 362). It seems, however, that our stock is by no means complete, for Dr. Heinrich Samter, in the current number (Bd. 70, p. 176) adds considerably to it. We make this reference for those readers who take a special interest in folk-lore, and would wish to look up this article.

METEORS TRANSITING THE SOLAR AND LUNAR DISCS.—What apparently appear to be unique observations, recorded quite recently in America, are given in the current number of the *Revue Scientifique*. It seems that during the night of July 21 and 22 last, Mr. William Brooks, the director of the Smith Observatory at Geneva (New York), saw all at once a round dark body pass slowly before the bright disc of the moon, the latter being almost full. The apparent diameter of the body is given as about one minute, and the duration of its transit amounted to three or four seconds, its direction being from the east towards the west. The second observation was made about midday on August 22, by Mr. Gathmann, an American astronomer, but the place of observation is not stated. He saw a meteor pass before the solar disc, occupying a period of time amounting to eight seconds in its transit. It is suggested that this body is one of a great number which circulates round our planet; it does not seem at all necessary to assume that our earth is the centre of attraction, indeed it seems rather improbable, as the observation would then, no doubt, be more common. Our present idea of space is that it is a meteoritic plenum, and full of bodies traversing through it at various speeds and at various distances from us, so that the chances of making such an observation, especially at periods of shooting-stars, is not altogether impossible, but is likely to occur, provided the observer is fortunate and happens to watch a comparatively slow-moving meteor.

THE GREAT SEISMIC WAVE OF JAPAN.

FULL particulars of the terrible wave which devastated the coast of Japan last June, causing the destruction of 20,000 lives and 12,000 houses and other buildings, have recently been given in the daily papers. The official report made to the Japanese Government having now reached this country, it may be interesting shortly to summarise the particulars of this occurrence, and to give the causes which have been assigned for its creation; and also to refer to waves of a similar character that have occurred on former occasions and in other localities.

The wave appears to have originated at a short distance from that part of the coast of Japan which trends in a north-easterly direction from the northern part of Sendai, midway between Tokio and the island of Yezo or Hokkaido. From Kiukasan, the northern island of the Archipelago, the coast is fjord-like in character, abrupt mountain ridges running down almost to the water edge. In the bays and estuaries that interrupt the shore line several important towns and many fishing villages were situated; with a few exceptions these have all been destroyed. The distance over which the effect was felt has been variously given as extending over a length of coast of from 200 to 300 miles.

Suddenly, almost without warning, between eight and nine o'clock in the evening of the 15th, three successive waves, the highest estimated as being fifty feet in height, swept over the land bordering on the coast, and in a space of a few minutes had caused a frightful devastation of property and the death of nearly all the inhabitants. There was nothing to presage the disaster or give warning. The barometer gave no indication of anything abnormal in the atmosphere. About half an hour before the catastrophe three or four shocks of earthquake were felt—not violent shocks, but of the vertical kind, which are known to be dangerous. Shortly afterwards a booming sound came from the direction of the sea. At first the noise was only like that of a coming gale; rapidly it increased until the sound assumed the volume and din of artillery; then in a moment three successive waves, varying in height from twenty to thirty feet, came rolling on the shore. In a space of time of about two minutes these waves had accomplished their fearful work of devastation and ruin.

Beyond the destruction of life and property some remarkable incidents occurred. At Kamaishi one wave came curling round the land-locked bay from the left in a semicircle, meeting another wave, which came in from the right, and before the waters could recede a third wave came in from the centre. In five minutes the town was wiped out. Temples, houses, and vessels lying in the bay, were alike swept away, broken up and destroyed. A large two-masted schooner of 200 tons was left lying almost uninjured five hundred yards inland, in the centre of what had been a wheat field. Another had its bows stove in, its stern post and rudder carried away, its deck ripped open, and the planking of its sides broken in short lengths. Altogether nineteen schooners and junks were cast ashore, In one place, men swept out to sea from one side of a bay were thrown up alive on the opposite beach; and in another case, several persons were deposited on an island nearly three miles from the town whence the wave had carried them.

The disturbance was not felt at sea at any great distance from the shore. Fishermen engaged in their occupation near the centre of the disturbance off the coast of Shizukawa heard, as they supposed, the booming of big guns in the distance; looking seawards they saw the surface of the ocean heave in huge masses, which, after rising to a great height, broke in the middle and swept northward and southward, striking the coast with a deafening roar. The waves passed under the boats without swamping them, but the water in the vicinity of the shore remained so rough throughout the night that the fishermen could not make the land until the morning. In other parts fishermen, plying their trade four miles from the coast, on returning to shore in the early morning after the catastrophe, received the first notice of what had occurred; others, engaged three miles out in the same locality, encountered heavy breakers rolling from the north. A steamer which left Hakodate in the morning of the day of the disaster, and must have been near the scene of the calamity at the time it occurred, experienced nothing out of the common; and other passing steamers reported only an abnormal current.

The Japanese Government have self-recording tide gauges fixed at various parts of the coast. The three nearest stations to the scene of disturbance are situate at Ayukawa, in the Oshiaka district; at Hanasaki-mura, in the Hanasaki district; and at Misaki-Machi, in the Miura district in Choshi Bay. At the first station the sea had been calm all the day of June 15. Suddenly at 8.25 p.m. the water fell 7·9 inches; five minutes after it rose 4·59 feet; and after an interval of five minutes had fallen down again. After this there occurred a succession of waves at intervals of about four or five minutes. At 11 p.m. the height of the wave, as indicated on the gauge, was 6·56 feet; the difference between the maximum and minimum height of the waves being 8·86 feet. After this the water gradually subsided to the ordinary sea-level.

At the second station, at 8.50 p.m. the water fell 3·28 feet, followed by five or six disturbances in an hour. After this an accident to the gauge prevented any further record. At 8.10 the next morning, when the gauge was visited, the sea had become calm.

At the third station some small waves began to show at 8.40, their height being 7·90 inches, and occurring at intervals of five minutes, gradually decreasing in height until the normal condition was obtained.

From these records it appears that the influence of the wave was greatest at the north station, and that an interval of twenty minutes elapsed before the gauge at the southern station was affected.

The effect of this seismical disturbance of the crust of the earth was sensible all over its surface, so far as may be judged from the records of instruments thousands of miles distant. On June 15, the day of the earthquake at Japan, at about 8.30 p.m., Prof. Vicentini, in Italy, noted the commencement of the disturbance on the seismograph, and a similar disturbance was recorded on the instrument at Shide, in the Isle of Wight.

As to the cause of the disaster, Prof. John Milne, in an article in the *Geographical Journal*, states his opinion that this was due to a seismic, rather than volcanic origin. The disturbances which have occurred in this locality have been, without exception, confined to the eastern sea-board of Japan, where the land suddenly sweeps downward beneath the deep Pacific. Along the line of

this submarine slope, which forms one of the longest and sharpest contours on the surface of the earth, earthquakes are frequent. Some opinions have been expressed that the disturbance had its origin in a sudden collapse of the sides of the subterranean crater known as the Tuscarora Deep, a triangle-like depression off the north-east coast of Japan, which has a depth of 4665 fathoms, or over five and a half statute miles. This deep, however, lies too far away from the supposed site of the generation of the wave. The kind of disturbance that probably occurred in the bed of the ocean may be illustrated by what happened on land at Bandai-San in 1886. Here millions of tons of earth and rocks were hurled in a given direction with such force that an enormous wave of solid material traversed a distance of many miles at great velocity. Any similar disturbance happening at the bottom of the ocean might fully account for what took place on the coast of Japan in June last. The earthquake which took place in Japan in 1891, the shock of which was so great as to be sensible in Europe, resulted in a fracture upon the surface of the earth for a distance of from forty to sixty miles. The ground, which on one side rises from 4000 to 6000 feet, was lowered relatively to that on the other side from 20 to 30 feet; river-beds were compressed, and valleys narrowed by the lateral movement.

That great submarine earthquakes result in the change of the ocean bed, is well known to those who have charge of cables near volcanic regions. It has been ascertained that when a cable has been broken at two points, the soundings have shown that there has been so great an increase in the depth that it has been necessary to select a fresh line for the cable in order to avoid the site of the disturbance. That the movement originated in the bed of the ocean, is evidenced by the fact that deep-sea shell-fish were found stranded on the high ground swept by the waves; and that in one place the fishermen found their nets floating on the surface upside down, they evidently having been cast up by the submarine disturbance.

Ever since the ninth century records exist of earthquake-waves which have devastated these coasts, but in no case have the results been so disastrous as on this occasion. The great earthquake-wave of 1891 caused the loss of life of over 7000 persons.

The exact locality of the disaster extends from the island of Kinkwa-San on the south (N. lat. 38° 15′, E. long. 141° 30′) to Hachinohe on the north (N. lat. 40° 30′, E. long. 131° 30′), the coast here assuming a convex shape. Between these points nearly every town and village were visited by the wave. The general direction of the wave appears to have been north by east.

Of previous examples of earthquake-waves, that due to the Lisbon earthquake of 1755 is matter of history. This wave rose to a height of forty feet in the Tagus, leaving the bed of the river dry as it rolled inwards. It was experienced at sea 120 miles west of St. Vincent, shaking vessels so violently that men were thrown from the deck; and its effect reached as far as this country, the water rising from eight to ten feet on the coast of Cornwall.

In 1868, and again in 1877, earthquake-waves rolled over the coasts of Peru, causing great devastation and loss of life. On the former occasion the U.S. warship *Watteree* was thrown up on the coast and carried inland one and a half miles; the second wave, in 1877, carrying it inland a still further distance. These waves, originating at a distance of about 9000 miles, off the South American coast, took nearly twenty-four hours before their effect reached the coast of Japan, where they rose and fell at intervals varying from ten minutes to half an hour, alarming the inhabitants and causing them to fly to the high land.

The volcanic upheaval at Krakatoa, in 1883, shook the whole of Java, and the sea-wave inundated the coasts of that country and Sumatra, causing a loss of 36,000 lives. The lava, mud, and ashes from this eruption darkened the air for fifty miles, and reddened the light of the sun for months after the catastrophe. The coast-lines were altered, and peaks on which lighthouses had been erected disappeared.

Several instances were given in NATURE of March 7, 1895, of earthquake-waves having been encountered by vessels at sea; and again, in November 10, 1895, of an earthquake-wave which burst on the shores of Madeira in 1891.

In January 1894, the *Normania* (of the Hamburg-American line), when 750 miles out from New York, encountered one of these waves. A stiff gale which had been blowing had moderated, and, while the vessel was running at full speed, an enormous wave was observed "masthead high" coming forward like a solid wall, and reaching as high as the bridge, wrecking the upper-deck-house, containing the music-room, ladies' room, and officers' quarters, and injuring several of the crew.

Numerous other instances could be quoted of these waves, which are frequently erroneously called "tidal waves," but which no doubt have their origin in some volcanic disturbance in the bed of the sea.

THE AMERICAN ASSOCIATION MEETING, 1896.

THE forty-fifth annual meeting of the American Association took place from August 24 to 29, at Buffalo, at which town it has now met four times, and although one of the smallest attended of recent meetings, seems to have been a very pleasant gathering. In most of the Sections full complements of communications were presented, notably so in those devoted to Chemistry, Botany, Geology, Anthropology, and Physics. The arrangements, a programme of which has reached us, appear to have been made with great care, and evidently no pains were spared to ensure the success of the meeting. Space will not permit us to print the addresses of the retiring President and Vice-Presidents; suffice it to say that they well sustain the standard of merit fixed by previous deliverances.

The retiring President, Mr. Edward W. Morley, took as the subject of his address "A Closed Chapter in Science." He spoke of the investigations into atomic weights of elements, in reference to their mutual relation so long supposed to be expressed in integrals in accordance with Prout's hypothesis. This hypothesis is now seen to be erroneous, so that it marks a closed chapter. The careful and repeated investigations of Morley himself and of others for many years, but mainly during the decade since the last Buffalo meeting, have proved that the ratio of atomic weights of hydrogen and oxygen, for instance, can only be expressed by a fraction, and is very nearly that of 1 to 15·88; it cannot possibly be that of 1 to 16. The same result has been found for many other elements with sufficient accuracy to establish the conclusions finally, and beyond the possible limits of error.

Mr. Carl Leo Mees, Vice-President of Section B (Physics), spoke on "Electrolysis and some associated Problems in Molecular Dynamics." In Section C (Chemistry), Mr. W. A. Noyes took as the subject of his address "The Achievements of Physical Chemistry." Mr. F. O. Marvin, in Section D (Mechanical Science and Engineering), discoursed on "The Artistic Element in Engineering." The subject of the address of Mr. B. K. Emerson, before Section E (Geology and Geography), was "Geological Myths." Section F (Zoology) was addressed by Mr. Theodore Gill on "Some Questions of Nomenclature." In Section G (Botany) the address was by Mr N. L. Britton on "Botanical Gardens." Miss Alice C. Fletcher spoke to Section H (Anthropology), on "The Emblematic Use of the Tree in the Dakotan Group"; and Section I (Social and Economic Science) was addressed by Mr. Wm. R. Lazenby, on "Horticulture and Health."

It will have been noticed that no mention is made in the foregoing list of Section A (Mathematics and Astronomy); but we are informed that Mr. Wm. E. Story, the Vice-President of the Section, was not present at the meeting, and his proposed address was not received, and could not therefore be delivered. The Vice-President of Section F (Zoology), instead of speaking, as he intended, on "Animals as Chronometers for Geology," spoke on nomenclature.

A commemorative meeting was held in recognition of the sixty years of professional work of Prof. James Hall. Prof. Hall was present at the meeting of the Association, as was another founder of the Association, Dr. Charles E. West, of Brooklyn.

Three founders of the Association have died within a few months, viz. Bela Hubbard, Thomas T. Bouvé, and Josiah D. Whitney.

The nominating Committee have presented the name of Wolcott Gibbs for President, and they recommend that the next meeting be a merely formal one, to be held at Toronto, August 17, 1897, to welcome the British Association for the Advancement of Science.

Among the business transacted was a resolution deprecating legislation against vivisection; while another favoured the metric standard of weights and measures, and recommended further legislation to secure its adoption.

APPLICATION OF RÖNTGEN RAYS TO THE SOFT TISSUES OF THE BODY.

WHEN the photographs which accompanied Prof. Röntgen's original paper were reproduced, the question was frequently asked, Shall we ever be able to photograph every part of the human skeleton? The developments have been very rapid, and now that it has been demonstrated that we can practically photograph the whole human skeleton in life, and throw shadows of a great portion of it upon fluorescent screens, we wonder the question was ever raised. It was quite natural that a similar demand should spring up for further extension of the art, so that other tissues than the osseous might be revealed by the same methods. Like many other observers, I early satisfied myself that we could examine and photograph certain organs within the cavities of some of the lower animals, such as the frog, rabbit, fish, &c. Further, in a considerable number of photographs of the deeper-seated structures, faint shadows of the human body were now and then obtained indicating the position of certain muscles, fasciæ, and even organs like the heart itself. While experimenting, like others, with the object of overcoming the difficulties of photographing the skeleton, I made a series of observations with a view to testing how far it would be possible to obtain photographs, or shadows upon fluorescent screens, of the contents of the three great cavities of the human body as well as the surrounding osseous walls. So far these experiments indicate promise of future development, and a few photographs are here reproduced, more by way of showing what may yet be accomplished than as an evidence of what has already been done.

In placing the following statements before the readers of NATURE, I desire to emphasise the importance of combining the study of the physical with the purely medical aspect of the question. To begin with, whatever progress may in the future be made with Röntgen rays, it must be remembered that the discovery itself came from the physical laboratory. Naturally, in the advancement of the study, certain aspects of the question will be more easily overcome by those familiar with normal and pathological tissues; others will just as naturally fall to be investigated by those engaged in physical research. Of course no line of demarcation can ever be drawn between these two, and the physician or surgeon who desires to pursue the subject must to a certain extent be conversant with physical science. On the other hand, the physicist will require to make himself somewhat familiar with the needs of those engaged in the study of animal and vegetable tissues. In this paper, therefore, while demonstrating some of the earliest examples obtained in this newer branch of the art, I desire to point out wherein we need the aid of those engaged in the physical laboratory. In so doing, I shall refer for the most part to the examination of the soft tissues of the human body, although it must never be forgotten that the use of Röntgen rays is not limited to any one part of the animal kingdom, and, further, that the structures in the vegetable kingdom are also being investigated by its means.

In attempting to photograph the soft tissues of the body, it might be thought they offered so little obstruction to the passage of Röntgen rays as compared with the bones, that less force would be required to demonstrate their presence. In other words, the natural suggestion was that if the bones of the extremities were to be photographed with certain apparatus in a given time, by diminishing the exposure we might be able to catch the soft tissues before they disappeared. This, of course, is true to a certain extent, and, in a certain number of my experiments, I was able, by carefully judging the exposure, to photograph not only the bones themselves in disease, but the fleshy parts, and this with such accuracy that the surgeon could see the internal pathological change and the external configuration of the part as well on the same plate. But when it came to the examination of the organs of the body, it was found that the rule did not apply as might have been expected, and instead

FIG. 1.—Pelvis of lad with femora, &c.

of a less force it became evident that we would require more force. For example, in one successful attempt to photograph the lungs of the frog, I was able to demonstrate their presence and a deposit in one of the lobes of the right side, and this with an ordinary Paget plate, the exposure only being something like the time represented to give twenty successive flashes of the tube due to twenty interruptions of a mercury interrupter with a current registering ten volts and ten ampères across the terminals, the spark being about six inches, and the focus tube one of Newton's small earliest pattern. In this case, however, the

tube was removed six inches from the animal. Those familiar with this work will immediately see that, considering the difference in size of the human body, a tube placed at that distance could not possibly give the same result on a plate or fluorescent screen. To begin with, we know that there is a definite relationship between the distance at which the photographic plate is removed from the object to be photographed on the one hand, and the distance between the object and the Crookes' tube on the other. In other words, to get anything like sharp definition it becomes necessary to remove the tube to a considerable distance, which means of course loss of power, and consequently more difficulty in seeing objects on a fluorescent screen, and a longer time in exposing a plate. The distance must vary in given cases, and experience, after careful experiment, in the present state of our knowledge can only determine at what distance the tube is to be placed, although we very often get a valuable suggestion by first examining an object on the fluorescent screen, and noting the distance of the tube from the object.

FIG. 2.—Coin impacted in gullet of boy aged six.

But another difficulty has now to be considered. Suppose we wish to try to photograph the heart. The patient must be placed on his face so that the organ may be as near the photographic plate as possible, and naturally the spine and other organs which we do not wish to be photographed will be between the object and the Crookes' tube. On the other hand, if we wish to photograph the spine, it may be necessary to omit the tissues of the heart and lungs. A still better example may be found in the case of the head, where the rays have to pass through the whole of the cranium, and yet the surgeon may desire to photograph the inside of only one side of the skull. Again, with renal calculus we do not wish to photograph the intestines lying in front, nor the muscles of the back behind. Fortunately the construction of the focus tube helps us in this way, and in an earlier number of NATURE of this year I pointed out a method by which this might be accomplished. The Röntgen rays springing from the platinum anode diverge from a point, consequently if we place the tube near the right side of the head, and the photographic plate on the left, the shadows caused by those structures immediately next the tube are so diffuse that they scarcely appear on the negative, while a sufficient number of the rays still pass through to photograph the part of the head which is in contact. By carefully arranging the tube therefore, one may photograph the heart, sternum and ribs by the same method; and if the patient be placed on his back, lying on the sensitive plate, these structures will be omitted, but the spine will be photographed. We can, also, by the same method photograph any part of the skull at will. Considering what has been said in the previous paragraph, it might be here argued that, seeing we are placing the tube near the body, less power will be required; but if we reflect in the case of the abdominal, thoracic, and cranial cavities, there is such density of tissue to overcome that we are more than ever in need of greater energy.

Following out these indications, I made a series of experiments and observations upon the apparatus at my disposal, and came early to the conclusion that more powerful currents would be necessary. Instead of measuring these in the usual way by the length of the spark of the coil, I placed Lord Kelvin's cell tester and ampère-meter in the circuit with a rheostat, so as to control the current at will, and taking a large German coil, in which the wires were thicker than the English form, the currents were gradually increased up to nearly thirty ampères. The experiments were pushed to such an extent that the focus tubes would not stand the molecular strain, and for this reason, at the instigation of Dr. J. T. Bottomley, several strands of wire were fused in the end of the tube bearing the kathode, while the anode was made adjustable so that the platinum might be removed at any distance from the kathode until the maximum result was obtained. There must be a relationship between the amount of energy passed into the coil, on the one hand, and the force coming out from the focus tube after being transformed. In other words, the coil is simply a transformer of a certain amount of energy which gives rise to conditions within the tube, which again give rise to X-rays. It was evident I had pushed this to the limit of the present make of tube. The question will naturally here suggest itself to those familiar with the subject, Is it necessary to use such currents, or could we not do with less energy by properly economising the force in the transformer and vacuum tube? The question is a very proper one, as all experimenters know that some tubes will give better results than others with a certain amount of force passed through a particular apparatus. This is yet to be settled, as well as the questions involving the amount of current absolutely necessary; the best form of coil; whether the coil itself is the best kind of transformer; and lastly, and probably most important of all, the conditions of the tube itself, and they all afford examples of what has been previously stated about the further need for physical research. What is here meant by the above statements is simply: with the apparatus as it stands at present, to get certain results, one is

forced to use greater currents than might have been expected. But throughout the experiments, either upon fluorescent screens or in photography (I do not meantime enter upon the question of whether the maximum luminescence on the screen is the proper condition for obtaining the best result on the sensitive plate), the conditions were kept as nearly as possible uniform. In a previous paper in NATURE, I pointed out the advantage of a good interrupter, emphasising in attempts at instantaneous photography the value of the mercury form; but whether we use the latter or render the screw of the Apps' coil more tense so as to get larger sparks, any one watching the effect upon the ampère-meter and the fluorescent screen at the same time, will soon appreciate how important it is to control the current by means of the rheostat throughout the experiment. I have made experiments upon different kinds of glass for tubes; different sized kathodes; thicknesses of anodes; various materials for the latter; tubes have been sent to me by Mr. Friedrich, with a request that they might be compared with English forms; the Berlin Electrical Company have also placed their tubes at my disposal, but after many trials I know nothing so important as the constant attention to the vacuum throughout the exposure. Some of the best photographic results in the deeper structures of the body were obtained by the small and earliest form of Newton's tube. Another method of control is to place the two poles attached to the secondary coil at a certain distance from each other. This, of course, is used in testing the length of the spark before beginning the experiment. If these be too near during the exposure the sparks fly across, and the current being short-circuited the tube is cut out, but when the space is increased the tube becomes luminescent. This distance should be noted, and may be used to control the amount of electricity passing through the tube, as alteration in the vacuum causes the sparks again to fly across. By means of the spirit-lamp or Bunsen burner a little heat applied to the bulb at once corrects the vacuum, and a certain uniformity of condition within the tube results.

It may here be pointed out that in using fluorescent screens for the deeper structures of the body, barium-platino-cyanide in some instances gives a better result or a darker shadow than the potassium salt. I am quite aware of the fact that the potassium is more luminous, and it may be that it is a matter of construction of the screen or the particular specimen employed, because samples of these salts vary in their effects. After using a large number of different materials I, like others, have fallen back entirely upon the potassium or barium salts, but employ both, and the barium has the great advantage of being a good practical agent well suited for hospital purposes, and durable. I have still in my possession a screen made of this salt early in March of this year, and, although small in size, it gives as good results as any of my newer screens. I find a darkened room for medical purposes much better than any form of cryptoscope. Under favourable conditions many parts of the face and head can be distinctly seen on the screen. In some instances I have seen foreign bodies, such as shot in the scalp; in another I was able to differentiate, in a case of paralysis of the extremities, between fracture of the skull with pressure on the soft tissues from the effusion of blood and obstruction due to a star-shaped fracture, as opposed to the diagnosis of a bullet which was thought to be situated at a particular spot. The tissues of the neck may easily be searched for foreign bodies which obstruct the rays. Photographs of all these can of course be obtained, and I need hardly point out that, in the present state of our knowledge, the photographic plate reveals in some instances what the screen fails to show. There is one curious exception to this, where the movements of the organ are rapid, such as in the heart, because this necessarily interferes somewhat with success owing to the movement during the exposure of the plate. Passing to the chest, the outline of the pleural spaces may be seen, and in one case condensation of the apex of the lung was thrown as a shadow upon the screen. The heart itself as a body in motion, the ascent and descent of the diaphragm, the liver covered with the diaphragm, can also be made out. The majority of those conditions have been photographed as well as observed, and I have a series of pictures showing enlargement of the heart, enlargement of the liver, and in one case renal calculus. It need hardly be said in addition that every part of the trunk and extremities, as far as the osseous parts are concerned, have been photographed. I do not use fluorescent screens in photography, one amongst other reasons being that the plates used were much larger than any screen in my possession.

While these statements seem to indicate considerable progress in the art, I desire expressly to interpret them in the light a surgeon or physician would view them, lest any misconception should result. When one reads of instantaneous photography, direct inspection or photography of so many of these tissues, it may be argued that we have now brought the subject to a thoroughly practical issue; but it is not so. For this reason I have placed these statements before your readers, in the hope that those engaged in the physical research may know how much we are yet in need of their aid. Take the statement of rapid or instantaneous photography; a careful perusal of the valuable summary in the pages of NATURE for April 30, shows that this statement is applied to the extremities for the most part. It need hardly be pointed out that what the surgeon desires is instantaneous photography of every part of the body, particularly where there is movement. Further, the reader may imagine that in seeing the movements of the heart, one can examine it much as the physiologist does the beating of the same organ in the frog during dissection; but it is not so. Before the movements of the diaphragm and heart, the limits of the pleural cavities, and

FIG. 3.—Thorax and upper extremities (adult), faint shadows of viscera.

the pathological changes in the tissues of the same, can be of great value to the physician, much more has yet to be done. The serious investigator is more impressed with what has yet to be done, than elated with what has already been accomplished. It is with great pleasure that I read in the columns of NATURE of the continued advances of those well fitted to engage in the study of the properties of Röntgen rays in the physical laboratory; and while we have reason to be pleased that the rays have been clearly proved to be of great value in the diagnosis of certain affections, every part of the apparatus must be investigated and improved upon before we obtain thoroughly satisfactory results. JOHN MACINTYRE.

SCIENCE IN THE MAGAZINES.

PROF. H. F. OSBORN, curator of vertebrate palæontology in the American University of Natural History, New York, contributes to the *Century Magazine* a popular account of prehistoric quadrupeds found in the Rockies during the past few years,and to be exhibited to the public at that museum in October. Interest in his description is greatly increased by nine remarkably fine illustrations (reproduced from water-colour drawings by Mr. Charles Knight), designed to give an idea of the animals as they probably appeared in life in their natural surroundings. Another interesting article in the *Century* is made up of extracts from the journals of the late Mr. E. J. Glave, whose journey to the Livingstone Tree had such a melancholy termination. On July 8, 1894, Mr. Glave reached the tree beneath which Dr. Livingstone's heart is buried. Jacob Wainwright, the Nassick boy who read the burial service, cut on the tree the words: "Dr. Livingstone, May 4, 1873. Yazuza, Mniasere, Vchopere." The body was roughly embalmed and carried to Bagamoyo, on the coast opposite Zanzibar, afterwards to be taken to England and buried in Westminster Abbey. As to the tree, Mr. Glave wrote in his journal: "Although done twenty years ago, the inscription is in a splendid state of preservation. The tree shows no disfigurement, and, moreover, the carving is not on the bark but on the grain of the tree itself. It is a hardwood tree, three feet in diameter at the base; at thirty feet it throws out large branches; its top is a thick mass of foliage. When Livingstone died the heart and other viscera were buried beneath this tree, and the bark was cleared off for a space of two and a half feet square; in this space Jacob Wainwright (whose account my discovery verifies to the letter) carved the inscription with no dunce's hand, the letters being well-shaped and bold. The tree is situated at the edge of the grass plain, and is very conspicuous, being the largest tree in the neighbourhood. It is about five miles south south-west from the present site of the village of Karonga Nzofu, an important Bisa chief, whose father was a friend of Livingstone. Chitambo's is now ten miles away. It was originally near the tree; in fact, Livingstone died a few minutes' walk from the old village of Chitambo." The tablet which Mrs. Bruce—the daughter of Livingstone—sent out by Captain Bia and Lieut. Franqui to commemorate the explorer's death, was put up by them eight miles from the spot where he died, and was afterwards carried off by the chief of a slave caravan.

"There is scarcely a modern skull preserved in our great anatomical museum beside those of abnormal malefactors. There is no fairly representative collection of the variations of our race; and there is no means of learning the characteristics of it in contrast to those of other races. This is far more the case in other directions; any solid comparative study of man's framework is as yet utterly impossible. Of many races not a single skeleton is preserved; and those of which we know a little are only shown by a few scanty specimens, of which the history and details are scarcely ever recorded. Of both past and present races a collection of at least a few dozen specimens of each race, precisely dated and localised, are the smallest amount of material which would enable us to begin a scientific treatment of the varieties of man." So writes Prof. Flinders Petrie in the *National Review*; and he suggests that, to systematise the study of man, a large museum should be established where examples of every object of human workmanship can be preserved. He is sanguine enough to think that this great repository of the works of man will be realised in the course of a few years. Such an institution would undoubtedly be of service to science. From this proposal of Prof. Petrie's, ethnologists may profitably turn their attention to a paper on "African Folk-Lore," contributed by A. Werner to the *Contemporary*. While staying for some months in East Central Africa, the authoress collected a number of traditional tales of the Mangánja, and she now relates them. Many of these stories deal exclusively with animals; and all of them proceed on the assumption that animals, human beings, and inanimate objects feel and act in much the same manner. There is a striking similarity between these myth-stories and the stories of "Uncle Remus"—a fact which goes to confirm the opinion that the latter originated with the African.

Prof. Ray Lankester reviews Mr. Archdall Reid's speculations on "The Present Evolution of Man" in the *Fortnightly*. "Mr. Reid," he says, "seems to be under the impression that the lines, or rather two of the lines of the present evolution of man have been definitely and satisfactorily indicated by his speculations. I am far from admitting that he has done more than demonstrate and draw attention to some tendencies of that evolution. . . . I am by no means convinced that the present and future evolution of man is being determined exclusively or even mainly in the simple way and by the obvious factors which he has placed before us."

Two editorial notes in *Scribner* deserve mention. In one a plea is made for the adoption of the metric system throughout the United States. The Bill introduced last session, and which will again be brought before Congress in the coming session, provides for the substitution of the metric system immediately in practically all the departments of the Government of the United States, and the adoption of the metric system of weights and measures as the only legal system to be recognised after the first day of January, 1901. The second note referred to is on Summer Schools, or vacation courses. It appears from a report of the U.S. Bureau of Education, that more than three hundred vacation courses, dealing with all branches of knowledge, are now held at various educational centres throughout the world.

In the *Strand Magazine*, Sir Robert Ball, continuing his series of astronomical articles, describes the discovery of Neptune, his treatment of that well-worn subject being illustrated with several interesting pictures. A number of reproductions from curious photo-micrographs form the chief feature of Mr. W. G. FitzGerald's article on "Some Wonders of the Microscope" in the same magazine. There is also a story dignified as an "Adventure of a Man of Science," which has for its scientific foundation the cure of madness by mysterious capsules. Even this flimsy basis is better than the description, in last month's *Strand*, of the use of a camera to obtain a photograph, by means of Röntgen rays, of a stolen diamond inside the thief's body. We should have thought it was known by this time that cameras are not used in Röntgen photography. Sir C. H. T. Crosthwaite shows a little better acquaintance with the subject in a story entitled "Röntgen's Curse," contributed by him to *Longman's*. The central figure of the story concocted a liquid which, when painted on the insides of his eyelids, made him as perspicaceous as a platino-cyanide screen excited by Röntgen rays. The capacity thus gained proved anything but a source of enjoyment to the experimenter. The idea may be good enough for a story, but a cautious man of science would have tried his wonderful liquid on one eye, and not on both.

In the *Sunday Magazine* there are two popular articles of interest to naturalists: one describes and illustrates sculptures of animals adorning a number of ecclesiastical buildings; and in the other Mr. C. J. Cornish writes on nightingales' nests, his account being illustrated by photographs from life.

Chambers's Journal has, as usual, several popular articles on science.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. H. R. NORRIS, Mathematical and Science Master of Ipswich Grammar School, has been appointed Head-master of Barry Intermediate and Technical School, Glamorganshire.

THE Finance Sub-Committee of the Bradford Corporation recently held a special meeting and decided to allocate the following grants under the Technical Instruction Act:—Bradford Technical College, £2875; Free Library, £300; Boys' Grammar School, £500; Girls' Grammar School, £100; Mechanics' Institute, £300; School Board, £1000; Church Institute, £100; Blind Institute, £50.

THE Holiday Courses of Lectures delivered last month at Jena are reported to have been a great success. The lectures were grouped as follows :—(*a*) Natural Science, including Astronomy, Botany, Physics, Zoology; (*b*) School Hygiene, Physiological Psychology, Philosophy, Pedagogics; (*c*) Conversational German, Literature, History. The attendance at the courses was better than at those of last year's gathering, no fewer than 108 being present, representing thirteen nationalities. Seventeen of the students were English.

THE Committee of Technical Instruction, in their annual report to the Oxfordshire County Council, remark "that the District Committees have in most cases carried out their duties in a satisfactory manner. Those District Committees who have availed themselves of the assistance of the Parish Councils have found the benefit of so doing, as they have been able to get into closer touch with the needs of each parish." The wisdom expressed in the last paragraph seems obvious; yet we are afraid the hint needs to be repeated to other than the District Committees located in Oxfordshire. The report in question tells of much good work accomplished.

THE Report of the Governing Body of the Battersea Polytechnic for the years 1893–94–95 contains much information of a gratifying character. During the period the institution has been open—some two years—not less than 6000 individual students have attended its classes. The sum of £67,840 has been raised; the Polytechnic is in receipt of its full endowment, and is now in its third educational session, with a regular attendance of 2850 students. In accordance with the provisions of the scheme, and the requirements of the chief industries of the neighbourhood being borne in mind, it was, at the outset, decided that the initial work of the Polytechnic should consist of (*a*) evening classes for young men and women in technology, science, art, domestic economy, music, commercial and general subjects, with provision for gymnastics and other recreative and social work; (*b*) day schools for boys who have passed through the elementary schools and desire further education of a technical and scientific character; (*c*) Saturday classes of an advanced character for teachers. Success all along the line seems to be the summing up of the report.

THE British Consul-General at Frankfort, in the course of his latest report, quotes certain official information supplied to the Italian Government in regard to the cost of University study in Germany. To obtain the degree of Doctor of Law at Berlin costs 1300 marks, and for a Doctor of Medicine about twice that sum. The details are as follows :—Fee for matriculation, 18 marks; fee for examination for the medical faculty, 242 marks; diploma fees for the law faculty, 335 marks; for the faculty of medicine, 440 marks; fees for all lectures necessary to pass the various examinations in the law faculty, 400 to 500 marks, and in the medical schools, 800 to 1200 marks. To these must be added 150 marks for printing the candidate's dissertation, 300 marks for books for a law student, and 500 marks for the books and instruments of a medical student. These, of course, do not include the cost of living. For a law student who studies in a town where his parents do not live, 5000 marks must be allowed for board, lodging, and clothing during his course, and 7600 to 8000 marks for the 4½ years of a medical student's course. The cost of a civil engineer's course, including that of living, is estimated at 6000 marks for four years. At other German Universities the cost would be somewhat less, but the difference would not be very great, for the main item—the cost of living—is very much the same in all University towns. Foreign students often prefer the smaller Universities, especially those in South Germany.

A RECENTLY published Parliamentary paper shows that out of the funds entrusted to the Board of Agriculture for educational purposes in Great Britain during the financial year ended March 31 last, sums amounting to £7850 have been distributed in specific grants to eighteen institutions named. Since the first grant made by Parliament in 1888 the sums have increased from £2930 to £7850. These sums are divided under two main heads—general agricultural education under collegiate centres, including dairying and experiments (this item has increased from £200 to £6100); and special and provisional grants, which have decreased in eight years by nearly £1000. Major P. G. Craigie, Director of the Intelligence Division, who has drawn up this report for the President of the Board, says that considerable local efforts are now being made to make up for the conspicuous lack of educational facilities among the agricultural community of Great Britain to which the inquiries of the Departmental Committee of 1887–88 directed attention. The grants awarded were to the following eight collegiate centres in England and Wales :—University College of North Wales, Bangor, £800; Yorkshire College, Leeds, £800; Durham College of Science, Newcastle-on-Tyne, £800; University College of Wales, Aberystwith, £800; University Extension College, Reading, £700; University College, Nottingham, £450; Cambridge and Counties Agricultural Education Committee, £400; South-Eastern Agricultural College, Wye, £150; to the Eastern Counties Dairy Institute, Ipswich, £300, and the British Dairy Farmers' Association £300—in each of these two cases for dairy instruction; and to the Bath and West and Southern Counties Society £350, for special cheese and cider research and agricultural experiments. This brings the total for England and Wales to £5850. The remaining £2000 is distributed in Scotland thus :—Two collegiate centres, Glasgow and West of Scotland Technical College £650, and University of Edinburgh £550; University of Aberdeen, for agricultural instruction, £150; Scottish Dairy Institute, Kilmarnock, for dairy instruction, £300; the Highland and Agricultural Society, £100, and the Aberdeen Agricultural Research Association, £100—in both cases for agricultural experiments; and the Royal Botanic Garden, Edinburgh, £150, for instruction to working foresters and gardeners.

SCIENTIFIC SERIALS.

Symons's Monthly Meteorological Magazine, August.—"The Thames run dry," by the Editor. It is less than 200 years since men walked across the bed of the river, near London Bridge; but the old bridges were almost like weirs in the obstruction offered to the flow of the water. The various dates since the year 1114 are given, the last being September 14, 1716. In this year, owing to a long drought and a strong westerly storm at the time in question, the Thames lay perfectly dry above and below bridge, with the exception of a very shallow channel, and many thousand people are said to have passed it on foot.—The first use of kites in meteorology, by A. L. Rotch. It has been stated that the first use of a kite in connection with meteorology was by Dr. Franklin in his experiments on atmospheric electricity in 1752; but Mr. Rotch points out that Dr. A. Wilson, of Glasgow, explored the temperature of the higher regions by raising a number of paper kites, with thermometers appended, in 1749. An account of one of the experiments is contained in *Trans.* Roy. Soc. Edin., vol. x. part 2. This method was successfully employed on several occasions in that and the following year.

Wiedemann's Annalen der Physik und Chemie, No. 8.—Contact electricity, by W. Nernst. The author formulates a theory of contact electricity based upon ionic velocities. Both ions of an electrolyte must diffuse equally rapidly, as otherwise an enormous accumulation of electricity would take place. The unequal velocities due to the unequal mobility of different ions must be compensated by a potential difference $\frac{dP}{dx}$. Hence the equation

$$U\left(\frac{dp}{dx} + c\frac{dP}{dx}\right) = V\left(\frac{dp}{dx} - c\frac{dP}{dx}\right),$$

where U and V are the mobilities of the anion and kation, p the osmotic pressure, and c the concentration of the solution.—Bolometric investigations of the absorption spectra of fluorescent substances and ethereal oils, by Bruno Donath. The measurements were made with a quartz prism, and all lenses were replaced by mirrors. It was found that the fluorescent bodies uranine, eosene, fluoresceine, æsculine, and chlorophyll show no absorption of the thermal spectrum down to wave-lengths of 2·7 μ. A chlorophyll solution 3·2 mm. thick has a region of strong absorption extending from the visible band in the red to the green rays. This region cannot be detected by the eye alone.—Emission spectrum of a black body, by Willy Wien. The author endeavours to reduce the number of hypotheses at the basis of the present theories of radiation. He also utilises Maxwell's theory of the distribution of velocities of molecules, but otherwise obtains his results on purely thermodynamic lines.—The new elements in cleveite gas, by J. R. Rydberg. This is an attempt to disentangle the spectrum of the supposed third new constituent of the gas from cleveite. The author calls

it "parhelium" (Pa) and assigns to it an atomic weight of about 3.—Distance action of the force of absorption, by W. Müller-Erzbach. The author claims to have proved that the absorptive force exercised, say, by iron oxide upon carbon bisulphide vapour is capable of acting across a thin layer of a substance like water or glycerine which is perfectly neutral itself. This molecular force is, unlike that of ordinary molecular attraction, capable of action at distances not exceeding 0·0025 mm. across intervening bodies.—Röntgen rays, by Otto Müller. In the course of an attempt to produce diffraction of X-rays, a shadowgraph of wire gauze was obtained under a metallic cylinder which screened the plate from the action of the rays. The distance between cylinder and plate was 20 cm. The author interprets the observation as a proof of the turbidity of the air to some at least of the X-rays, and ascribes the effect to diffusion.

Bollettino della Società Sismologica Italiana, vol. ii., 1896, No. 2.—New methods for geodynamical investigations, by G. Grablovitz. A valuable description of the instruments erected in the geodynamic observatories of the island of Ischia, including various forms of levels, horizontal pendulums, instruments for measuring the vertical movements of the ground, and seismoscopes.—New form of continuously recording seismometrograph, by A. Cancani.—On the so-called presentiment of earthquakes by animals, by A. Cancani.—On some facts resulting from microseismic observations, by G. Vicentini. A reprint of a paper already noticed in NATURE.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, August 31.—M. A. Chatin in the chair.—The Perpetual Secretary announced the death of M. Henri Résal, member of the Section of Mechanics.—On the subject of prime numbers, of which any given number cannot be a primitive root, by M. de Jonquières.—External characters and modes of distribution of the small tubercles or tuberculoids of the Leguminosæ, by M. D. Clos. A morphological study of the tuberculoids on the roots of nine sub-species of the Papilionacæ. In the two other groups of the Leguminosæ Cæsalpiniæ and the Mimosæ, the presence of the tubercles is by no means so frequent as in the Papilionacæ.—Memoir on the Law of Newton and on some problems in general mechanics, by M. E. La Combe.—On the effect of systematic errors in levellings of precision, by M. Ch. Lallemand. It is shown that, with a few exceptions, levellings of precision are subject to systematic errors, which may vary from ·05 mm. to 0·3 mm per kilometre, and hence are of more importance than the accidental errors to which, up to now, attention has been chiefly directed. It has not been found possible to connect these systematic errors with the particular instruments employed, with the observers, with the nature of the ground, or with the atmospheric conditions.—On a class of propositions analogous to the Miquel-Clifford theorem, by M. Paul Serret.—The deflection of the X-rays behind opaque bodies, by M. E. Villari. A gold-leaf electroscope, placed in the cone of shadow of a sheet of lead, was found to be discharged by the X-rays at rates which showed that the shadow was deepest at the centre.—Researches on the double chlorides, by M. R. Varet. A thermochemical study of the double chlorides formed by mercuric chloride with other chlorides.—Action of the soluble oxidising ferment from mushrooms on the phenols insoluble in water, by M. E. Bourquelot. The two naphthols are oxidised by this ferment in a manner that may serve to distinguish them, α-naphthol giving a violet colouration, β-naphthol a white precipitate, which dissolves to a yellow solution in ether.—On the freezing-point of milk, by MM. Bordas and Génin. Fifty samples of milk gave freezing points varying from $-0°\cdot44$ C. to $-0°\cdot56$ C., and the conclusion is drawn that the determination of dilution with water by cryoscopy is neither simple nor certain.—On the organisms causing disease of the silk-worm, by M. J. M. Krassilschtschik.—A telegraph cable attacked by Termites, by M. E. L. Bouvier.—On the secretory nerves of the trachea, by M. V. Thébault.—On the conjugation of the zoospores of *Ectocarpus siliculosus*, by M. C. Sauvageau.—On the velocity of sound, by M. G. W. Pierces.—On the resolution of the general equation of the fifth degree, by M. L. Mirinny.—On the geographical situation of submarine islands, by M. Reilly.

GÖTTINGEN.

Royal Society of Sciences,—The *Nachrichten*, Part 2 (Mathematico-Physical Section), 1896, contains the following memoirs communicated to the Society:—

April 25.—On the theory of automorphic modular groups, by R. Fricke.—On an optical effect of an electric field conditioned by the dependence of the dielectric coefficients on the strength of the field, regarded from the standpoint of the electromagnetic theory of light, by F. Pockels.

May 9.—Researches from the Göttingen University Laboratory (IV.), by O. Wallach. (1) Condensation-products of cyclic ketones, and syntheses within the terpene group; (2) a bicyclic ketone $C_{14}H_{22}O$; (3) benzylidene-methylhexanone $C_7H_{10}O:CHC_6H_5$; (4) dibenzylidene-methylhexanone $C_6H_5CH:C_7H_8O:CHC_8H_5$; (5) benzylidene-menthone; (6) benzylidene pulegone; (7) dibenzylidene-suberone $C_6H_5CH:(C_7H_8O):CHC_6H_5$; (8) dibenzylidene-methylpentanone $C_6H_5CH:C_8H_6O:CHC_6H_5$.—On the principles of Hamilton and Maupertuis, by O. Hölder.

June 20.—Attempted demonstration of orientation in the surface-conduction of electricity; on the continuous transition of an electrical property through the boundary-layer between solid and fluid bodies; on the conduction of electrified air; an experiment on magnetic currents, each by Ferdinand Braun.

July 4.—A contribution to the theory of complex magnitudes consisting of n primary units, by David Hilbert.

July 18.—Fluorescence and the kinetic theory, by W. Voigt.—On the change in the mode of vibration of light in passing through a dispersing or absorbing medium, by W. Voigt.

BOOKS AND SERIALS RECEIVED.

BOOKS.—Outlines of Psychology: E. B. Titchener (Macmillan).—Babylonian Magic and Sorcery: L. W. King (Luzac).—By the Deep Sea. E. Step (Jarrold).—British Association, Liverpool, 1896. Excursion Guidebook (Liverpool, Philip).—A Dictionary of the Economic Products of India. Index (Calcutta).—The Book of the Dairy: Dr. W. Fleischmann, translated by C. M. Aikman and R. P. Wright (Blackie).—Elementary Quantitative Chemical Analysis: Dr. F. Clowes and J. B. Coleman (Churchill).—Lehrbuch der Algebra: Prof. H. Weber, i. Band (Braunschweig, Vieweg).

SERIALS.—Geological Magazine, September (Dulau).—Geographical Journal, September (Stanford).—Edinburgh Medical Journal, September (Pentland).

CONTENTS.

THURSDAY, SEPTEMBER 17, 1896.

LYDEKKER'S GEOGRAPHICAL HISTORY OF MAMMALS.

A Geographical History of Mammals. By R. Lydekker, B.A., F.R.S., V.P.G.S., &c. Cambridge Geographical Series. Pp. xii + 400. (Cambridge: University Press, 1896.)

THERE can be no doubt about Mr. Lydekker's qualifications to enter on the field of geographical distribution. The author of the excellent treatise on mammals in the "Royal Natural History," after serving an apprenticeship on the Indian Geological Survey, has arranged and catalogued the splendid series of remains of extinct mammals in the British Museum. Alone of European palæontologists, he has likewise visited the rich collections recently amassed in the museums of Buenos Ayres and La Plata. He has thus the advantage, not possessed by any previous writer on the subject, of a more intimate acquaintance with the past history of mammals than perhaps any other living naturalist has been able to accumulate, and on the present occasion has made good use of it.

In the main outlines of his scheme of geographical regions, as propounded in the introductory chapter of the present work, Mr. Lydekker follows generally the well-known arrangement of Sclater and Wallace; but, as we shall presently show, deviates from their views in several important particulars. As to the correctness of the primary division of the earth's surface into "Notogæa," "Neogæa," and "Arctogæa," all authorities, we believe, whose opinions are worthy of consideration, are now nearly in accord. This arrangement was first proposed by Mr. Sclater in 1858, in one of the "Manchester Science Lectures," though other titles were then given to the two last-named divisions. In 1890, Dr. Blanford adopted the same primary areas with slight alterations in the names. The "anonymous writer" in *Natural Science*, who, in 1893, assigned the names "Notogæa," "Neogæa," and "Arctogæa" to these three divisions, we take to have been Mr. Sclater himself, or some one inspired by him. At any rate, these are the terms adopted by Mr. W. L. Sclater in his articles on the "Geography of Mammals," lately published in the *Geographical Journal*; and we agree with Mr. Lydekker in regarding them as the simplest and best-selected names yet proposed. But, having proceeded thus far, we have only arrived at the front of our difficulties.

"Arctogæa" embracing the whole land-surface of the world except Australia (*Notogæa*), and South and Central America (*Neogæa*), requires subdivision. Messrs. Sclater and Wallace have proposed to effect this in the most simple and natural way, by making four "regions" out of "Arctogæa"—namely, the Ethiopian, Oriental, Palæarctic and Nearctic, and thus to recognise six primary zoological regions. They admit, of course, that these six regions are not of exactly equal value. But in such a matter, as in all other classifications, convenience should be consulted to a certain extent, and the "six regions" are very convenient, being readily defined and easily recognisable, and are much more in accordance with facts than any other regions that have yet been suggested. Mr. Wallace has set all this fully forth in an address to the Cambridge Philosophical Society, which was published in this journal in April 1894.[1] We regret to observe that Mr. Lydekker scoffs at this excellent and well-reasoned article, and speaks of it as an attempt to "bolster up" a lost cause. Yet he continually refers to Mr. Wallace's writings throughout his work, and acknowledges his eminence as an authority on geographical distribution.

Mr. Lydekker summarises his objections to the "six regions" of Sclater and Wallace as follows:—

"It has the serious drawback that it gives no greater rank to Australasia and South America than to the other divisions; whilst the remarkable difference between the faunas of Africa and Madagascar is overlooked. Further, the northern parts of America are widely separated from those of Europe and Asia, to which they are faunistically allied."

Mr. Lydekker proposes the following modified scheme to meet the defects thus specified.

I. Notogæic realm	(1) Australian region.
	(2) Polynesian region.
	(3) Hawaian region.
	(4) Austro-Malayan region.
II. Neogæic realm	Neotropical region.
III. Arctogæic realm	(1) Malagasy region.
	(2) Ethiopian region.
	(3) Oriental region.
	(4) Holarctic region.
	(5) Sonoran region.

We venture to assert that these suggested modifications only lead Mr. Lydekker into further difficulties.

In the first place, realm is only region "writ short," and is hardly sufficiently distinct to be used in a different sense. Why not say simply "Notogæa," "Neogæa," and "Arctogæa"—three orthographically constructed compounds, of which the meaning is patent to all acquainted with the subject? Again, the so-called "Polynesian region" is a mere appendage of the Australian region. As Mr. Lydekker well says, it is "characterised by the general absence of non-flying mammals." But the birds—the next important group—are mostly Australian in character, though a few genera are autochthonous. The Moas (*Dinornithidæ*) which, until lately, played such an important *rôle* in it, are certainly as nearly related to the Cassowaries as to any other group. Lories (a specially characteristic Australian type) are scattered over it. In fact, Polynesia can only be properly placed as one of the sub-regions of the Australian region.

Much the same may be said of Mr. Lydekker's "Hawaian region." The only mammal of the Sandwich Islands is a bat. The land-birds are certainly very peculiar, and mostly restricted to the group. It is, as yet, not ascertained to what outside forms they are most nearly related; it is quite certain, however, they have nothing to do with America. But to rank the Hawaian Islands as constituting a division equal in value to the Ethiopian region is simply impossible. The alleged inequality of Sclater and Wallace's six regions is a trifle compared with this feat of Mr. Lydekker. The best place for the so-called "Hawaian region," so far as our present knowledge goes, is within the boundaries of the Australian.

[1] See "What are Zoological Regions?" (NATURE, vol. xlix. p. 611).

Again, the "Austro-Malayan region" of Mr. Lydekker is merely a border-land between the Australian and Oriental regions, and has no sort of claim to the rank here assigned to it. It has few, if any, indigenous types of mammals, and cannot for a moment be put on a par, as it is in Mr. Lydekker's scheme, with the Ethiopian region, which has numerous families, both of mammals and birds, restricted to its area. Mr. Lydekker's "Austro-Malayan region," except Celebes—which is certainly a difficult subject—may be safely annexed to the Australian region. Celebes has been also referred there by Mr. Wallace, but on the whole we opine that it would be better placed as a distinct sub-region of the Oriental region.

We now come to Mr. Lydekker's "Arctogæic realm," or "Arctogæa," as we prefer to call it. This is divided by Mr. Lydekker into five regions, as shown above. As regards the separation of Madagascar and its islands from the Ethiopian region, under the name of the "Malagasy region," there is much to be said in its favour, and we do not deny that our author has some good grounds to go upon. It is obvious that the mammal fauna of Madagascar, as well shown by Mr. Lydekker (see p. 215 of his work), is one of the most extraordinary on the world's surface—not only for what it has, but still more, perhaps, for what it has not. We can, therefore, offer no serious objection to Dr. Blanford's proposal (accepted by Mr. Lydekker) to raise the rank of Madagascar from that of a sub-region (as it has been treated by Messrs. Sclater and Wallace) to that of a full-blown region.

Mr. Lydekker's Ethiopian and Oriental regions remain much the same as Mr. Wallace's; but as regards the next two—the Holarctic and the Sonoran, there is a wide difference. Mr. Lydekker, misled by Dr. Merriam and other American writers, who take a narrow view of the subject, proposes to annex the northern part of America to the northern part of the Old World, calling it altogether Holarctic; while the more southern part of North America, down to the boundaries of the Neotropical region, is denominated "Sonoran." To assent to this proceeding, however, would only involve us in further difficulties. Most of the "Sonoran" mammals penetrate far into the north, outside its supposed limits. On examining the list of the Sonoran types (p. 379) and that of the "Western Division of the Holarctic region" (p. 344), we shall find them meagre indeed, and quite insufficient to support a distinction between two regions. The polar area may, in fact, be safely regarded as border-land between the Palæarctic and Nearctic regions. It must be recollected that Northern America was, in comparatively recent days, covered by the polar ice-sheet even much more extensive than that of Northern Europe. This destroyed nearly all animal life, and drove most of the remainder into Mr. Lydekker's "Sonoran region." On the disappearance of the ice-sheet the northern land was naturally repeopled from the adjacent part of Asia across Behring's Straits, as well as from the Sonoran region. Hence, no doubt, came such characteristic Palæarctic forms as the sheep, the bison, the mountain-goat, and the stag into North America. Of these, however, all but the mountain-goat have penetrated into the Sonoran region, and we have some doubts whether *Haploceros* is not likewise to be met with within its supposed boundaries.

Another serious objection to the "Holarctic region" is that, as regards birds at least, by adopting it we shall mix up some of the most characteristic forms of the New World in the same primary division as those of the Old World. Take, for example, the humming-birds—a most eminently typical group of the New World. Humming-birds range all over Canada in the summer, and on the west of the continent pass up to Alaska. Following Mr. Lydekker's scheme, we should have to place the Trochilidæ in the "Holarctic list." The same would be the case with the Mniotiltine warblers (*Mniotiltidæ*), the greenlets (*Vireonidæ*), the hang-nests (*Icteridæ*), and other forms which are absolutely restricted to America, and utterly foreign to the Old World (*Palæogean*) avifauna.

On the whole, therefore, we cannot doubt that Mr. Lydekker would have been more prudent to stick to the old-fashioned "six regions." Even had he not quite agreed to them, he might have sheltered himself under Mr. Wallace's authority, and safely followed his leadership.

In his intimate acquaintance with fossil mammals, Mr. Lydekker had, as we have already stated, a great advantage over his fellow-workers in the same field, and one of which he has not failed to make good use in some of his arguments. This branch of the subject is certainly much more completely discussed in the "Geographical History of Mammals" than in any other work of the same character, and we are duly grateful to the author for the many novel facts he has thus set before us. At the same time it should be recollected that, while we are pretty well acquainted with the present mammal-fauna of the earth and the facts of its distribution, we know comparatively little about the past. The "imperfection of the geological record" should be always in our minds when arguments are used taken from the little that is yet known of the ranges of extinct mammals, our notions of which may in many cases come to be seriously modified by discoveries yet to be made.

On the whole, however, we must allow that Mr. Lydekker's volume forms a valuable contribution to the "Cambridge Geographical Series," and that the general editor has done wisely in securing such a well-written essay on this branch of his subject from a palæontological point of view. Although we notice a few typographical errors, the volume is well printed, and excellently illustrated by numerous process-blocks introduced into the text, and by a chart of the zoological regions. Altogether it contains a large mass of information reduced into a small compass, and will meet, we are sure, with generous appreciation from all students of distribution.

THE RATIONAL STUDY OF PLANT-DISTRIBUTION.

Lehrbuch der Ökologischen Pflanzengeographie eine einführung in die kenntniss der Pflanzenvereine. Von Dr. Eugen Warming. Deutsche Ausgabe von Dr. E. Knoblauch. (Berlin: Gebrüder Borntraeger, 1896.)

AN account of the principles underlying the facts of the geographical distribution of plants has long been a desideratum. Although various persons have written on the subject, they have not, for the most part,

approached it from the point of view which, thanks largely to the often decried "laboratory system," we are enabled to do at the present time. In fact, until botanists had given up restricting their attention to species, and to the grosser external characters of plants, it was not possible for them to apprehend how intimately the welfare, and consequently the distribution, of the organism and of the species is bound up with minute and often apparently trivial details of structure. It is true that the general characters of what we may term the *Habitus* of groups of plants had been more or less clearly defined. Humboldt and Grisebach had already distinguished numerous dominant types, and had indicated the general nature of their relationships.

But what we want to find out is the causal *nexus* which exists between the plant, and the locality or conditions in which it lives. It is this, the biological, aspect of the question which is the important one for to-day. We are deeply conscious that life is a struggle between conflicting organisms more or less adapted to the conditions of life to which they are exposed. We know, too, that in this struggle, no factor is without its due weight in determining the final result. But we cannot hope to unravel the tangle of reasons which may account for the presence of this type here and its absence there, nor can we appreciate the nice adjustment between the individual constituents which compose the type, until we are in a position to investigate the inter-relations existing between the adaptation and the environment to which it responds. Before this could be, it was first necessary to obtain an insight, not only into the minute details of anatomy, but also into their connection with the functions discharged by the organism as a whole. Only then can we appreciate the true meaning of the peculiarities presented by members of such characteristic floras as alpines, epiphytes, mangrove swamps, and the like.

It is not that the problems of distribution have hitherto attracted but little interest—far from it—but that before they could be successfully grappled with, a laboratory training formed an indispensable preliminary. But it *is* only a preliminary. It is all very well to study collections of plants, whether in the form of pickled material, or herbarium specimens, or even as living beings in hothouses. It is only by travelling, and seeing the things as they actually grow under natural conditions, that one is in a position to estimate the importance of this or that structure, and its relation to the welfare or existence of the species. It may not be necessary to travel far in order to make some progress in this study. Our own country affords abundant opportunity to those who know how to use their eyes; still, there can be no question but that it is in tropical regions that the *purposefulness* of structural modifications most forcibly obtrudes itself on the mind of the observer.

The questions involved are most fascinating, and they are most intricate. Hence it is the more important that we should address our inquiries in an orderly manner if we are to successfully analyse and classify the numerous factors concerned. To indicate how this may be done is one of the objects of Prof. Warming's book, and he may fairly claim to have largely succeeded in his efforts.

He discusses, in the first place, the general effect of physical conditions on plant-life; and his remarks are always interesting, even where we do not quite agree with the conclusions to which he arrives. He then gives a short classification of the different characteristic groups of plants, which he assembles in four different divisions—the Hydrophytes, Xerophytes, Halophytes and Mesophytes, the last including what we may term normal vegetation. The key-note to his treatment of these four divisions is given in the ideal which he keeps before him, that of ascertaining the manner in which each type and each species places itself in harmony with its surroundings by means of morphological, anatomical, and physiological differentiation and adaptation. The book is essentially one of classification of these adaptations, and of the varied environments inhabited by plants, and it is one which ought to be read not only by botanists, but by all who care for the general questions concerning the distribution of living forms in water and on land.

J. B. F.

OUR BOOK SHELF.

Rivers and Canals. The Flow, Control, and Improvement of Rivers, and the Design, Construction and Development of Canals, both for Navigation and Irrigation; with Statistics of the Traffic on Inland Waterways. By Leveson Francis Vernon-Harcourt, M.A. In 2 vols. Vol. i., Rivers; vol. ii., Canals. 651 pp. and index; with 13 plates of illustrations. (Oxford: Clarendon Press, 1896.)

THE first edition of Mr. Vernon Harcourt's book on rivers and canals was published in 1882, and has been regarded as one of the standard books on the subjects of which it treats. The present edition is not merely a revise of the former one, but has been almost entirely re-written, and the subjects rearranged and brought up to date. The wide experience which the author has had, from being frequently called upon professionally to investigate and report on matters relating to rivers and harbours, and the active interest he has taken in the various navigation congresses which have been held in this and other countries during the last few years, fully entitle him to write with authority on the theory of river engineering, and the principles to be observed in carrying out works of improvement. The theoretical part of the book is supported by descriptions and illustrations of the chief works which have been carried out for the control and improvement of rivers, and the construction of canals. The book is written in a style that is thoroughly readable, and is not encumbered with detailed facts and information which, although of great value to an experienced engineer, are not required by a student or reader who wishes to become acquainted with general principles. On the whole, as would naturally be expected, the views expressed by the author are sound, and such as have received general acceptance by the most experienced engineers of this and other countries. There are, however, some matters dealt with on which engineering "doctors differ," and in these cases Mr. Vernon Harcourt would, perhaps, have added to the value of his book if he had given a little more credit to the views of other engineers who have devoted their attention to the same subject. The illustrations are very clear and effective, and add considerably in elucidating the descriptions in the text. In fact, both the author and the publisher deserve the thanks of the engineering profession for bringing up-to-date a work bearing on the management of our harbours and rivers, on the efficiency of which the prosperity of the navigation and commercial interests of this country so largely depend.

Elementary Practical Chemistry and Qualitative Analysis. By Frank Clowes, D.Sc. Lond., and J. Bernard Coleman, A.R.C.Sc. Pp. xvi + 224. (London: J. and A. Churchill, 1896.)

THIS book, which is founded on Prof. Clowes' larger "Practical Chemistry and Qualitative Analysis" is intended for the use of general students and of technical students in schools and colleges who are desirous of acquiring a general elementary knowledge of chemistry, and who propose to acquire this knowledge in the only true way, viz. by themselves performing experiments in a laboratory. For such students the book furnishes an admirable guide. The first eighty pages contain excellent instructions as to the preparation and use of apparatus, the methods of carrying out ordinary chemical operations, and the modes of demonstrating the properties of common gases and liquids. The remainder of the book is occupied with a course of qualitative analysis, which treats first, at considerable length, of the reactions for metals and for acid-radicles, and then of the actual analysis of simple and complex substances. There is, further, an appendix of useful tables and a good index.

The hand of the experienced and careful teacher is manifest throughout. The importance attached to cleanliness, neatness, and system in the rules given for working; the directions for the verification of the statements made, and for the keeping of the student's notebook; the precautions indicated as necessary for success in certain experiments, the careful attention to detail, and the emphasis given just where it is needed, show that the authors have knowledge not only of chemistry, but also of the "general and technical student," who, if he will observe the instructions, and work fairly through the book, cannot fail to acquire a real knowledge of his subject.

For boys and girls at school, we ourselves should recommend a course on somewhat different lines, starting, for instance, with air rather than with oxygen, following generally a historical sequence, taking the various chemical operations not *en bloc*, but as required in the course, and relegating qualitative analysis to a comparatively subordinate place. But taking things as they are, and accepting as a fact the existing requirements of various public examining bodies, this little work should prove widely useful as a carefully-arranged, clear, and accurate text-book.

Entomological Notes for the Young Collector. By William A. Morley. Pp. viii + 129. (London: Elliot Stock, 1896.)

THIS is a little book of the most popular kind, written with the intention of rendering the collecting of butterflies and moths easy to the youngest of beginners. It is illustrated by eight pages of figures representing apparatus, setting, &c., and the text is divided into twelve chapters, corresponding to the months of the year, each including a lesson on apparatus, collecting, rearing, &c., and a list of some of the principal *Lepidoptera* which appear in each month. The book may be useful to those for whom it is intended; and we congratulate the author on his good judgment in advising his readers to learn the Latin names, and to forget the English. Here and there a little revision would be useful; thus Entomology is defined as "that branch of natural history which bears special reference to four-winged insects known as butterflies and moths" (no other insects being even mentioned in the book); Cambridgeshire is the only locality given for *Papilio machaon* and *Vanessa antiopa*; *Lycæna artaxerxes* is said to be "generally distributed in England"; of *L. corydon*, we read "On chalk cliffs, common"; and moths which come to sugar are said, as a rule, not to come to light.

W. F. K.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Utility of Specific Characters.

IT is dangerous for a mere mortal to take part in the strife of the gods, or for "gyrating"[1] mathematicians to join battle with biologists. But as the enthusiasm of Prof. Weldon for his subject has so largely perturbed my normal gyrations, that I have devoted many months to the statistical theory of evolution, perhaps I may be permitted a word or two on the subject of the present controversy.

To demonstrate that natural selection, whether secular or periodic, is actually taking place in any species, and to measure its amount, is in the present state of our knowledge one of the grandest pieces of work that could be done. It would achieve for the Darwinian theory what Hertz achieved for the Maxwellian theory of light. At present no one has gone further in the direction of this demonstration than Prof. Weldon, and I am inclined to think with Mr. Thiselton-Dyer—and I take it in opposition to Prof. Lankester—that such a demonstration can only be achieved by the statistical method. If, however, we are to obtain a really solid result of that method, then the mathematical theory, and the logic used, must both be beyond suspicion. Now in any demonstration of the existence of natural selection two points must be borne in mind:

(*a*) A selective death-rate must be actually demonstrated. This is a problem for fine statistical theory.

(*b*) The correlation between organ and death-rate must be shown in itself to be not fortuitous. The character must have been selected because it is useful. This I take to be Prof. Lankester's point.

I propose to say a few words as to both (*a*) and (*b*).

It appears to me that both Prof. Lankester and Mr. Thiselton-Dyer allow that a selective death-rate has been established in the report on *Carcinas mænas* of 1894–5. This view I take to be entirely erroneous, and I so expressed myself to Prof. Weldon and several members of the Committee before the *Report* was published. What Prof. Weldon demonstrates is this—*that if crabs chanced to grow in a particular manner*, then there would be a relation between death-rate and the size of a certain frontal ratio. What is quite certain is that at the time the *Report* was published, nobody knew how crabs grew; and I very much doubt whether Prof. Weldon, after his laborious two years' study of the growth of crabs, would now uphold the hypotheses he then adopted, *e.g.*:

(i.) That size could be taken as a safe measure of age.

(ii.) That young crabs of the same frontal ratio do not "scatter" as they grow older.

(iii.) That the amount of growth of crabs of any given frontal ratio is entirely independent of that ratio.

Yet if these—to me very improbable—hypotheses be not accepted, the supposed demonstration of a selective death-rate in *Carcinas mænas* falls completely to the ground. The very hypothetical character of the conclusions of the *Report* of 1894–5, appears by his letter of August 26 to be now very fully recognised by Prof. Weldon himself. I am not, however, sure that it has been generally recognised. When the law of growth of crabs has been accurately ascertained, then I am convinced that it will require much more complex analysis than that of the *Report* to ascertain whether a selective death-rate does or does not exist. I should not have said so much on this first point did I not believe that next to blindly rejecting natural selection, the most dangerous course open to biologists is to accept a proof of its existence which is sure one day to be demonstrated as fallacious by one of the many opponents of Darwinism.

On the second point, surely Prof. Lankester is entirely in the right? It is not sufficient to show that there is a correlation between a certain frontal ratio and death-rate in order to assert that the frontal ratio is a cause of death-rate. Very probably it may be, but the demonstration is not logically complete, or at any rate a definition of cause has been adopted which does not appear

[1] The term is due to Prof. Lankester, who thus described us—I think it was to Mr. Thiselton-Dyer—in the early days of the Teaching University movement.

of much utility to science. If the height of the barometer be correlated with the frequency of explosions in mines, it would not appear utile to describe the barometer as a "cause" of the explosion. Or, to take another case, which is purely hypothetical, but which will, I think, illustrate Prof. Ray Lankester's point. There is, we will suppose, a purely random distribution of supernumerary teats in cows. But in my particular herd the two best milkers possess supernumerary teats (although there is no correlation between such teats and good milkers in general). I keep the calves of these two cows because they are good milkers, and by reason of this selection supernumerary teats become more and more common in my herd. At last I begin to preserve calves with supernumerary teats, really because this is a test of their descent from the good milkers, practically because I find them in themselves good milkers. Now, because I am a careful breeder, my cows may get a reputation at sales all over the country, and a correlation between supernumerary teats and good milkers may come to be generally recognised. This happens not because supernumerary teats are a cause of good milkers, but owing in the original instance to a *random* association of this variation with a utile variation. Thus, a primarily random association with a favourable variation may by the principle of heredity quite easily lead to a correlation which it would be of no profit to consider causal. If two characters be not correlated, and one be favourable to survival, then any selection of the favourable character, which hits a group of individuals having more than the average of the second character—and this may easily arise if we breed from comparatively few individuals—will by the principle of heredity lead to a *fortuitous* correlation. I do not assert that this is the case in the frontal ratio of crabs, but it seems to me that a link is really missing in the chain of demonstration. All causality is of course correlation, but the converse, which Prof. Weldon seems to hold and Prof. Lankester to controvert, is surely a dangerous doctrine?

KARL PEARSON.

September 10.

Specific Characters among the Mutillidæ.

THE discussion in your columns as to the utility of specific characters leads me to offer a few remarks on the Mutillidæ, an interesting family of Hymenoptera. In the arid region of the United States, this family is very numerously represented, and its members may be seen running about in warm weather, especially frequenting sandy places, roads and pathways. It is not at first apparent why the species should be so numerous, living under what seem to be identical or almost identical conditions; in 1893 (*Trans. Amer. Ent. Soc.*, xx. 343), I wrote: "It is difficult to account for the origin of so many species under conditions which can hardly at any time have been very diverse." But the region in question is inhabited by very many species of bees, the modifications of which have relation to a varied flora, as I have illustrated by particular instances elsewhere (*Proc. Ac. Nat. Sci. Phila.*, 1896, pp. 33–41). The various Mutillidæ are parasitic in the nests of these bees, and consequently do not live under identical conditions; we have a varied flora with its varied insect-visitors, and these with varied parasites, the whole series of phenomena intimately connected, though at first sight it would seem impossible to see any connection between the flowers and the mutillids, however indirect.

It must be a long time before the actual host-relations of all the mutillids are known, but I have a species now under observation, which may serve as an example. The bee *Diadasia diminuta* lives in colonies, burrowing perpendicular tunnels in the beaten pathway, which are produced somewhat above the level of the ground by means of fragile cylinders of sandy particles, designed to keep the tunnels from being filled with sand. The little *Sphærophthalma heterochroa* is the parasite of this bee, and the females may be seen in numbers running about between the burrows, now and then looking into them or entering. At once we see the utility of one of the specific characters of *S. heterochroa*—its small size. The larger species could not enter the small burrows of the bee.

The females of *S. heterochroa* are splendid little insects, ornamented with scarlet, black, and whitish. Like the females of all Mutillidæ, they are wingless. The much more active winged males, which are not so elegantly ornamented as the females, may be seen bustling about, looking for the latter. In the Mutillidæ, the females are very varied in colour, markings and structure; while the males are much more uniform. Thus, Cameron says ("Biol. Cent. Amer. Hymenoptera," p. 259): "This general resemblance of the males not only makes their specific determination a work of difficulty, but it adds greatly to the task of assigning them to their respective partners of the opposite sex." If the bright and varied colours and markings were due to activity or a "katabolic tendency," it is in the winged males that they ought to be found; not, as is actually the case, in the wingless females. But on the principle of utility there may be an explanation. The males have to look for their respective females, and I believe the ornamentation of the latter assists their recognition.

There is a whole series of Mutillidæ which are very plainly coloured, from tawny through various shades to black, never with any scarlet, or conspicuous markings. These (*Photopsis* and *Brachycistis*) are all nocturnal, without any exception, and come to lights in the evening. But the systematists who have described many of these insects, were totally unaware of this circumstance until I pointed it out recently!

The moral of all this is, that to understand the real meaning of specific characters we must study the species in nature. We are hardly more likely to understand natural phenomena from the examination of dead animals alone, than a Hottentot would be to understand the apparatus of telegraphy. And eventually, I believe even the pure systematist will have to base his work on biological observation. It has been fondly hoped all along that absolute criteria of specific distinction would be found in the insects themselves, without reference to their habits; and the searchers for such "hall-marks," driven from point to point, have at length taken refuge in the male genitalia. But only a few days ago I received the following in a letter from M. Ernest André, the distinguished French student of Hymenoptera, and particularly Mutillidæ.

"Comme je l'ai dit, je crois qu'on attache aujourd'hui une trop grande importance aux caractères tirés de l'appareil génital mâle. Ces organes sont très variables, difficiles à apprécier, et ne concordent pas toujours avec les autres caractères morphologiques."

T. D. A. COCKERELL.

N.M. Biological Station, Mesilla, New Mexico, U.S.A., August 25.

The Khmer of Kamboja.

IN NATURE, June 11, p. 135, I see a short notice of the work being done in Australia by Prof. R. Semon, of Jena, and that he classes the "Khmer and Chams of Kamboja" as "primitive Dravido-Australians." I hope that some of your anthropological experts will, as soon as possible, correct this serious mistake.

Mr. A. H. Keane, in NATURE, January 6, 1881, p. 222, calls these people "Caucasian"; but I presume they are now (1896) known to be what Captain C. J. F. S. Forbes classed them, *i.e.* Mon-Anam, in his "Languages of Further India."

J. R. Logan, in his "Ethnology of the Indo-Pacific Islands," published at Singapur and Pinang, in the *Journal* of the Indian Archipelago (1847–63), rightly classes them as Mon-Anam, giving their linguistic peculiarities and alliances, pronouns, &c., and numerals up to ten, those from one to five being identical with our Kol, Sontal, Munda, Ho (the most western relatives of the Mon-Anam alliance), and quite different to the Dravidian numerals.

The now civilised Kambojans admit that the "Khmer dom" are the older and purer stock, whence they are descended, and that they were *hill savages*, which carries out what we know so far of these early *pre*-Burmo-Tibetan races from the Asam side.

Both in physique and languages, the Dravido-Austral aboriginal of India (south of Himalaya) and the Mon-Anam group are very distinct; the former are seen purest in the Andamani and Negrito, in whom there is an entire absence of Tibetan elements.

But the Mon-Anam (which includes the Khmer) were formed, as a race, by the mixture, or fusion, of (Sifan) Tibetans with the Dravidians, lying south of Himalaya from Nipal to East Asam. At one time this "Mon-Anam" race appears to have covered all Northern and Eastern Bengal, the whole of Asam,

and the Ultra-Indian peninsula from Asam to Singapore, and even to have extended to the Nicobars, Sumatra, Borneo, and beyond. In India, on the west and south-west, the Tibetan element dies out, and gives place (gradually) to the purer Dravidian; and here we have the darker Kol alliance, Munda, Santali, &c., say, roughly, two-thirds Dravidian and one-third Tibetan. Further east we have the relics of the Mon in the Bodo, Koch, Mech, of the Delta, and the Garo-Kasia of the eastern hills, the latter more Tibetanised by later influx of Tibetans *viâ* Bhutan, in physique and language.

Then we have a vast gap filled in by later "Tibeto-Burman" races, and come to the "Mon" of Pegu, who show the influence of the Tibeto-Burman inroads, though retaining still considerable "Kasia" affinities. The Kambojans, again, are another fragment of the "Mon," having specific affinities with Manipuri and Naga. Anamese, again, is distinguished by its strong Manipuri, Barak, and Kol affinities, and showing Chinese influence, through contiguity becoming more monosyllabic.

Logan, who was an expert in these matters, tells us that "the Mon-Anam pronouns and numerals are partly Tibetan and partly Dravidian—chiefly the latter—but most of the substantial roots are similar to Tibetan, and the forms more archaic than the current Tibeto-Burman." "The difference between Dravido-Australian and the Mon-Anam formation is so great, that it may be safely connected with the equally striking difference of race, and ascribed to a long-continued and total ethnic separation during its earlier history. The Simang and Andamani are the purest remnants of a pre-Himalaic race in Ultra-India, and it is probable that similar Dravido-Australian tribes [lived there] before the Mon-Anam entered the region."

But one of the best proofs that the "Khmer" are not Dravido-Australian is, that the Australian races all have numerals on the binary basis 1 and 2. Three is 2 + 1 or 1 + 2. Four is 2 + 2. Five is 2 + 2 + 1. This was formerly the basis of the Dravidian system, long before the Mon-Anam (Khmer, &c.) arose as a race.

The Australians, in fact, whose languages are known to be "more nearly allied to the South Indian than to any other in the world," left India (probably *viâ* Malaya) when the Dravidian numerals were in their earliest binary stage, and before the quinary and denary stage was developed (anywhere).

As Logan says, "the quinary and denary systems, with the Dravidian mode of forming 8 and 9, indicate affinities belonging to much later periods. The civilisation which originated them, was unknown to Dravido-Australian at the time when the early Asonasian migrations took place."

That the Mon-Anam race, much later on, passed south and east from India, and extended even over the Archipelago and Pacific, is becoming yearly more obvious, not only through study of physique and customs, but the number of roots, pronouns, and vocables having a *Himalaic* basis. But from their site of origin, in Bengal, as a (locally varied) admixture of Tibetan and Dravidian, the racial development and tribal drift may have been exceedingly slow, like the drift we see now among the much later Tibeto-Burman, Lushai Kuki, &c., taking probably many centuries in crossing from the Delta, across the Barak, Manipuri, and Naga Ranges, and *viâ* Asam. That they at one time covered the entire Ultra-Indian peninsula, is obvious from the position of the fragments of the race, due to the intrusion of the Tibeto-Burmans, but that they extended to the east of the Upper Irawadi is doubtful.

The Cham, Charay, Stieng, Xong, Samré, and Kuy are the less known, more barbarous, and purer branches of the Mon-Anam living in the Mekong highlands. S. E. PEAL.

Sibsagar, Asam, August 11.

Dr. Siemens' Smokeless Open Grate.

DR. C. WILLIAM SIEMENS described fully in NATURE (November 11, 1880, vol. xxiii. p. 25) a smokeless open gas and coke or gas and anthracite grate for living rooms, costing about one halfpenny per hour in fuel. Will any users of this grate, who may have an extended experience of it, relate their views, and state any lessons its use may have taught them?

During an extensive hunt for a smokeless open cheap grate, Dr. Siemens' grate is the most satisfactory I have yet found.

FRED. WM. FOSTER.

Neckinger Mills, Bermondsey, September 9.

THE LIVERPOOL MEETING OF THE BRITISH ASSOCIATION.

IV.

LIVERPOOL, *September* 14.

WE are now on the eve of the meeting. St. George's Hall opens to-day as the British Association reception-room; and although the attendance on the first day will be chiefly Liverpool people securing their seats for the evening addresses in the Philharmonic Hall, still a few visitors from other parts of the country and from abroad have already arrived, and many more are expected to-morrow. We are told that more associates' and ladies' tickets have now been taken than at any previous meeting on the corresponding day. These local ticket-holders, along with the members from elsewhere who have intimated their intention of being present, amounted on Saturday to about 2500, so there is every prospect of a large gathering.

The last meeting, for the present, of the Executive Committee was held on Friday, and the local secretaries then reported upon the final arrangements for the meeting. The Town Hall will probably prove too small for the number of members who will attend the first soirée, so the Lord Mayor (the Earl of Derby) has obtained permission from the Committee of the Exchange News-room, across the Exchange "flags," to utilise that magnificent hall, in addition to the Town Hall, for his entertainment. A covered way will connect the front of the Exchange News-room with one of the windows of the Town Hall.

At the second soirée, to be held in the Walker Art Gallery, Free Library, and Museum, the accommodation is ample, so provision is being made for short lectures, lantern demonstrations, and various exhibitions in the galleries and rooms.

Nothing has been changed in the other Sectional arrangements and fixtures already announced, but some additional information has come in regard to the probable work of Sections F, I and K.

In the Section of Economics and Statistics, the proceedings on Thursday will be opened at 11 a.m. by the Presidential Address, which will deal with economic teaching and political action. The treatment of this subject derives much additional importance from the almost unique position in the political world occupied by the President (the Right Hon. L. Courtney). In due consideration that the meeting takes place this year in a large and busy commercial centre like Liverpool, several sittings will be devoted to the consideration of matters of directly practical, as well as theoretic interest. On one day (Friday), three papers will be given by Messrs. Cannan, W. H. Smith, and Blunden on various points relating to the incidence of local rates and the municipal control of finance. On another day (Monday), future dealings in produce will form the subject of discussion. Papers dealing with these will be contributed by Mr. H. R. Rathbone, Mr. Charles Stewart, and Mr. E. Helm, of Manchester. On Tuesday, currency questions will occupy the attention of the Section, when it is hoped that a paper will be read in defence of the gold standard by Mr. William Fowler. One or two papers from the bimetallic side are promised. Other papers will deal with the effects of trade amalgamations, systems of economic education, standard of value and money, commercial crises, cotton prices, remedies for agricultural distress, metric system, and other important subjects. It is hoped that there will be included among these a consideration of some aspects of charitable and philanthropic trading, by Mr. C. S. Loch.

In the "Section of Physiology, including Psychophysics and Experimental Pathology," in addition to the Presidential Address and the discussions already

announced, some of the more important communications will be as follows:—"Further researches on the phonograph," and "Method of transmitting wave-forms from phonograms to paper," by Prof. McKendrick; "Method of distinguishing between organic and inorganic compounds of iron in the tissues," by Prof. Macallum (Toronto); "The glycoside constitution of proteid matter," by Dr. Pavy; "Photometry and Purkinje's phenomenon," by Prof. Haycroft; "Bacteria and daily food," by Dr. Kanthack; "The physiological effects of peptone when injected into the circulation," by Prof. Thompson; "The influence of glycerine on the growth of bacteria," by Dr. Markton Copeman; and other papers by Dr. Dupuy, Prof. Gotch, Dr. Mann, Prof. Boyce, &c.

In the Botanical Section, in addition to what we have already announced, there will be two discussions on subjects which have for some time past been prominently before the botanical world. On Friday, Mr. Francis Darwin will introduce a discussion on the movements of water in plants; others will be followed by a demonstration by Prof. Vines of a new method for the experimental investigation of some phenomena connected with the transpiration current. On Tuesday the second discussion will be opened by Prof. Farmer. This will treat of problems connected with the vegetable cell, but it is hoped that with the co-operation of zoologists the subject will be discussed from a general biological point of view.

An important contribution by Miss Sargant will be made after the discussion, in which some recent researches on nuclear division will be described.

On Monday afternoon, as already announced, a lecture will be delivered by Mr. Thiselton-Dyer, on the geographical distribution of plants. The subject will be treated in such a way as to appeal not only to specialists, but to the wider circle of those who possess a general interest in botanical science.

The papers to be communicated to this Section may be summarised as follows. Prof. Magnus (of Berlin), Mr. Ellis, and Mr. Vaughan Jennings have promised communications on the life-history of various Fungi. Dr. Mann is expected to make a communication on work carried out by Miss Huit on the physiology of the tentacles of *Drosera;* and from Dr. Morris (of Kew), there will be a contribution on some remarkable pathological effects produced by a West Indian weed, *Leucæna glauca*. On Monday, Prof. Chodat (of Geneva) will give an account of conclusions arrived at as the result of his important researches on Algæ, relating to such problems as the origin of sexuality, and the relationship of Algæ to the higher plants.

Prof. Bower and Mr. Lang (of Glasgow) will deal with investigations on Vascular Cryptogams, and from the latter author may be expected an exceedingly important contribution which has a direct bearing on the question of alternation of generations treated of in the President's opening address. Palæobotanical papers are to be read by the President and Mr. Seward on Palæozoic and Mesozoic plants. It is hoped that Prof. Trail (of Aberdeen) may give an account of his extensive researches on the variation in flower structure of the *Polygonaceæ;* and Mr. Scott-Elliot will probably read a paper on the effect of habitat on the habits of plants. Results of anatomical and physiological interest will be communicated by Mr. Keeble and Mr. Gwynne-Vaughan.

Although the hope that Nansen might have attended this meeting will not be realised, we shall have Sir Martin Conway fresh from Spitzbergen, and an account will be given by Mr. Montefiore Bryce of the experiences in Franz Josef Land of the Jackson-Harmsworth Expedition.

Amongst recent additions to the list of foreigners and Americans expected are:—Prof. Fokkar (Gröningen), Prof. Johannes Walther (Jena), Dr. Montelius (Stockholm), Prof. Keeler (Pennsylvania), Dr. Stolpe (Stockholm), Prof. Zacharias (Hamburg), Dr. Herrschen (Upsala), Dr. Johann Hjort (Christiania), M. Theodore Nica (Bucharest), Prof. Bohnslav Brauner (Prague), Prof. Nasini (Padua), Prof. Yves Delage (Paris), Prof. J. Berg (Stockholm), Prof. R. Chodat (Geneva), Prof. Kohlrausch (Berlin), M. J. Violle (Paris). Other distinguished guests who will attend were mentioned in a former article.

Before this appears in print the presidential and other opening addresses will have been given, and the character of the meeting will have declared itself; but as far as present indications afford a clue, we may expect an unusually large gathering, and a number of important discussions in the Sections. How far these forecasts and expectations have been realised will appear in our final article.

W. A. HERDMAN.

INAUGURAL ADDRESS BY SIR JOSEPH LISTER, BART., D.C.L., LL.D., P.R.S., PRESIDENT.

MY Lord Mayor, my Lords, Ladies, and Gentlemen, I have first to express my deep sense of gratitude for the great honour conferred upon me by my election to the high office which I occupy to-day. It came upon me as a great surprise. The engrossing claims of surgery have prevented me for many years from attending the meetings of the Association, which excludes from her Sections medicine in all its branches. This severance of the art of healing from the work of the Association was right and indeed inevitable. Not that medicine has little in common with science. The surgeon never performs an operation without the aid of anatomy and physiology; and in what is often the most difficult part of his duty, the selection of the right course to follow, he, like the physician, is guided by pathology, the science of the nature of disease, which, though very difficult from the complexity of its subject matter, has made during the last half-century astonishing progress; so that the practice of medicine in every department is becoming more and more based on science as distinguished from empiricism. I propose on the present occasion to bring before you some illustrations of the interdependence of science and the healing art; and the first that I will take is perhaps the most astonishing of all results of purely physical inquiry—the discovery of the Röntgen rays, so called after the man who first clearly revealed them to the world. Mysterious as they still are, there is one of their properties which we can all appreciate—their power of passing through substances opaque to ordinary light. There seems to be no relation whatever between transparency in the common sense of the term and penetrability to these emanations. The glasses of a pair of spectacles may arrest them while their wooden and leathern case allows them to pass almost unchecked. Yet they produce, whether directly or indirectly, the same effects as light upon a photographic plate. As a general rule the denser any object is the greater obstacle does it oppose to the rays. Hence, as bone is denser than flesh, if the hand or other part of the body is placed above the sensitive film enclosed in a case of wood or other light material at a suitable distance from the source of the rays, while they pass with the utmost facility through the uncovered parts of the lid of the box and powerfully affect the plate beneath, they are arrested to a large extent by the bones, so that the plate is little acted upon in the parts opposite to them, while the portions corresponding to the muscles and other soft parts are influenced in an intermediate degree. Thus a picture is obtained in which the bones stand out in sharp relief among the flesh, and anything abnormal in their shape or position is clearly displayed.

I need hardly point out what important aid this must give to the surgeon. As an instance, I may mention a case which occurred in the practice of Mr. Howard Marsh. He was called to see a severe injury of the elbow, in which the swelling was so great as to make it impossible for him by ordinary means of examination to decide whether he had to deal with a fracture or a dislocation. If it were the latter, a cure would be effected by the exercise of violence which would be not only useless but most injurious if a bone was broken. By the aid of the Röntgen rays a photograph was taken in which the bone of the upper arm was clearly seen displaced forwards on those of the forearm. The diagnosis being thus established, Mr. Marsh proceeded to reduce the dislocation; and his success was proved by another photograph which showed the bones in their natural relative position.

The common metals, such as lead, iron, and copper, being

still denser than the osseous structures, these rays can show a bullet embedded in a bone or a needle lodged about a joint. At the last conversazione of the Royal Society a picture produced by the new photography displayed with perfect distinctness through the bony framework of the chest a halfpenny low down in a boy's gullet. It had been there for six months, causing uneasiness at the pit of the stomach during swallowing; but whether the coin really remained impacted, or if so, what was its position, was entirely uncertain till the Röntgen rays revealed it. Dr. Macintyre of Glasgow, who was the photographer, informs me that when the presence of the halfpenny had been thus demonstrated, the surgeon in charge of the case made an attempt to extract it, and although this was not successful in its immediate object, it had the effect of dislodging the coin; for a subsequent photograph by Dr. Macintyre not only showed that it had disappeared from the gullet, but also, thanks to the wonderful penetrating power which the rays had acquired in his hands, proved that it had not lodged further down in the alimentary passage. The boy has since completely recovered.

The Röntgen rays cause certain chemical compounds to fluoresce, and emit a faint light plainly visible in the dark; and if they are made to fall upon a translucent screen impregnated with such a salt, it becomes beautifully illuminated. If a part of the human body is interposed between the screen and the source of the rays, the bones and other structures are thrown in shadow upon it, and thus a diagnosis can be made without the delay involved in taking a photograph. It was in fact in this way that Dr. Macintyre first detected the coin in the boy's gullet. Mr. Herbert Jackson, of King's College, London, early distinguished himself in this branch of the subject. There is no reason to suppose that the limits of the capabilities of the rays in this way have yet been reached. By virtue of the greater density of the heart than the adjacent lungs with their contained air, the form and dimensions of that organ in the living body may be displayed on the fluorescent screen, and even its movements have been lately seen by several different observers.

Such important applications of the new rays to medical practice have strongly attracted the interest of the public to them, and I venture to think that they have even served to stimulate the investigations of physicists. The eminent Professor of Physics in the University of College of this city (Prof. Lodge) was one of the first to make such practical applications, and I was able to show to the Royal Society at a very early period a photograph, which he had the kindness to send me, of a bullet embedded in the hand. His interest in the medical aspect of the subject remains unabated, and at the same time he has been one of the most distinguished investigators of its purely physical side.

There is another way in which the Röntgen rays connect themselves with physiology, and may possibly influence medicine. It is found that if the skin is long exposed to their action it becomes very much irritated, affected with a sort of aggravated sun-burning. This suggests the idea that the transmission of the rays through the human body may be not altogether a matter of indifference to internal organs, but may, by long-continued action, produce, according to the condition of the part concerned, injurious irritation or salutary stimulation.

This is the jubilee of Anæsthesia in surgery. That priceless blessing to mankind came from America. It had, indeed, been foreshadowed in the first year of this century by Sir Humphry Davy, who, having found a toothache from which he was suffering relieved as he inhaled laughing gas (nitrous oxide), threw out the suggestion that it might perhaps be used for preventing pain in surgical operations. But it was not till, on September 30, 1846, Dr. W. T. G. Morton, of Boston, after a series of experiments upon himself and the lower animals, extracted a tooth painlessly from a patient whom he had caused to inhale the vapour of sulphuric ether, that the idea was fully realised. He soon afterwards publicly exhibited his method at the Massachusetts General Hospital, and after that event the great discovery spread rapidly over the civilised world. I witnessed the first operation in England under ether. It was performed by Robert Liston in University College Hospital, and it was a complete success. Soon afterwards I saw the same great surgeon amputate the thigh as painlessly, with less complicated anæsthetic apparatus, by aid of another agent, chloroform, which was being powerfully advocated as a substitute for ether by Dr. (afterwards Sir James Y.) Simpson, who also had the great merit of showing that confinements could be conducted painlessly, yet safely, under its influence. These two agents still hold the field as general anæsthetics for protracted operations, although the gas originally suggested by Davy, in consequence of its rapid action and other advantages, has taken their place in short operations, such as tooth extraction. In the birthplace of anæsthesia ether has always maintained its ground; but in Europe it was to a large extent displaced by chloroform till recently, when many have returned to ether, under the idea that, though less convenient, it is safer. For my own part, I believe that chloroform, if carefully administered on right principles, is, on the average, the safer agent of the two.

The discovery of anæsthesia inaugurated a new era in surgery. Not only was the pain of operations abolished, but the serious and sometimes mortal shock which they occasioned to the system was averted, while the patient was saved the terrible ordeal of preparing to endure them. At the same time the field of surgery became widely extended, since many procedures in themselves desirable, but before impossible from the protracted agony they would occasion, became matters of routine practice. Nor have I by any means exhausted the list of the benefits conferred by this discovery.

Anæsthesia in surgery has been from first to last a gift of science. Nitrous oxide, sulphuric ether, and chloroform are all artificial products of chemistry, their employment as anæsthetics was the result of scientific investigation, and their administration, far from being, like the giving of a dose of medicine, a matter of rule of thumb, imperatively demands the vigilant exercise of physiological and pathological knowledge.

While rendering such signal service to surgery, anæsthetics have thrown light upon biology generally. It has been found that they exert their soporific influence not only vertebrata, but upon animals so remote in structure from man as bees and other insects. Even the functions of vegetables are suspended by their agency. They thus afford strong confirmation of the great generalisation that living matter is of the same essential nature wherever it is met with on this planet, whether in the animal or vegetable kingdom. Anæsthetics have also, in ways to which I need not here refer, powerfully promoted the progress of physiology and pathology.

My next illustration may be taken from the work of Pasteur on fermentation. The prevailing opinion regarding this class of phenomena when they first engaged his attention was that they were occasioned primarily by the oxygen of the air acting upon unstable animal or vegetable products, which, breaking up under its influence, communicated disturbance to other organic materials in their vicinity, and thus led to their decomposition. Cagniard-Latour had indeed shown several years before that yeast consists essentially of the cells of a microscopic fungus which grows as the sweetwort ferments; and he had attributed the breaking up of the sugar into alcohol and carbonic acid to the growth of the micro-organism. In Germany Schwann, who independently discovered the yeast plant, had published very striking experiments in support of analogous ideas regarding the putrefaction of meat. Such views had also found other advocates, but they had become utterly discredited, largely through the great authority of Liebig, who bitterly opposed them.

Pasteur, having been appointed as a young man Dean of the Faculty of Sciences in the University of Lille, a town where the products of alcoholic fermentation were staple articles of manufacture, determined to study that process thoroughly; and as a result he became firmly convinced of the correctness of Cagniard-Latour's views regarding it. In the case of other fermentations, however, nothing fairly comparable to the formation of yeast had till then been observed. This was now done by Pasteur for that fermentation in which sugar is resolved into lactic acid. This lactic fermentation was at that time brought about by adding some animal substance, such as fibrin, to a solution of sugar, together with chalk that should combine with the acid as it was formed. Pasteur saw, what had never before been noticed, that a fine grey deposit was formed, differing little in appearance from the decomposing fibrin, but steadily increasing as the fermentation proceeded. Struck by the analogy presented by the increasing deposit to the growth of yeast in sweetwort, he examined it with the microscope, and found it to consist of minute particles of uniform size. Pasteur was not a biologist, but although these particles were of extreme minuteness in comparison with the constituents of the yeast plant, he felt convinced that they were of an analogous nature, the cells of a tiny microscopic fungus. This he regarded as the essential ferment, the fibrin or other so-called ferment serving, as he believed, merely

the purpose of supplying to the growing plant certain chemical ingredients not contained in the sugar but essential to its nutrition. And the correctness of this view he confirmed in a very striking manner, by doing away with the fibrin or other animal material altogether, and substituting for it mineral salts containing the requisite chemical elements. A trace of the grey deposit being applied to a solution of sugar containing these salts in addition to the chalk, a brisker lactic fermentation ensued than could be procured in the ordinary way.

I have referred to this research in some detail because it illustrates Pasteur's acuteness as an observer and his ingenuity in experiment, as well as his almost intuitive perception of truth.

A series of other beautiful investigations followed, clearly proving that all true fermentations, including putrefaction, are caused by the growth of micro-organisms.

It was natural that Pasteur should desire to know how the microbes which he showed to be the essential causes of the various fermentations took their origin. It was at that period a prevalent notion, even among many eminent naturalists, that such humble and minute beings originated *de novo* in decomposing organic substances; the doctrine of spontaneous generation, which had been chased successively from various positions which it once occupied among creatures visible to the naked eye, having taken its last refuge where the objects of study were of such minuteness that their habits and history were correspondingly difficult to trace. Here again Pasteur at once saw, as if by instinct, on which side the truth lay; and perceiving its immense importance, he threw himself with ardour into its demonstration. I may describe briefly one class of experiments which he performed with this object. He charged a series of narrow-necked glass flasks with a decoction of yeast, a liquid peculiarly liable to alteration on exposure to the air. Having boiled the liquid in each flask, to kill any living germs it might contain, he sealed its neck with a blow-pipe during ebullition; after which, the flask being allowed to cool, the steam within it condensed, leaving a vacuum above the liquid. If, then, the neck of the flask were broken in any locality, the air at that particular place would rush in to fill the vacuum, carrying with it any living microbes that might be floating in it. The neck of the flask having been again sealed, any germs so introduced would in due time manifest their presence by developing in the clear liquid. When any of such a series of flasks were opened and re-sealed in an inhabited room, or under the trees of a forest, multitudes of minute living forms made their appearance in them; but if this was done in a cellar long unused, where the suspended organisms, like other dust, might be expected to have all fallen to the ground, the decoction remained perfectly clear and unaltered. The oxygen and other gaseous constituents of the atmosphere were thus shown to be of themselves incapable of inducing any organic development in yeast-water.

Such is a sample of the many well-devised experiments by which he carried to most minds the conviction that, as he expressed it, *la génération spontanée est une chimère*, and that the humblest and minutest living organisms can only originate by parentage from beings like themselves.

Pasteur pointed out the enormous importance of these humble organisms in the economy of nature. It is by their agency that the dead bodies of plants and animals are resolved into simpler compounds fitted for assimilation by new living forms. Without their aid the world would be, as Pasteur expresses it, *encombré de cadavres*. They are essential not only to our well-being, but to our very existence. Similar microbes must have discharged the same necessary function of removing refuse and providing food for successive generations of plants and animals during the past periods of the world's history; and it is interesting to think that organisms as simple as can well be conceived to have existed when life first appeared upon our globe have, in all probability, propagated the same lowly but most useful offspring during the ages of geological time.

Pasteur's labours on fermentation have had a very important influence upon surgery. I have been often asked to speak on my share in this matter before a public audience; but I have hitherto refused to do so, partly because the details are so entirely technical, but chiefly because I have felt an invincible repugnance to what might seem to savour of self-advertisement. The latter objection now no longer exists, since advancing years have indicated that it is right for me to leave to younger men the practice of my dearly loved profession. And it will perhaps be expected that, if I can make myself intelligible, I should say something upon the subject on the present occasion.

Nothing was formerly more striking in surgical experience than the difference in the behaviour of injuries according to whether the skin was implicated or not. Thus, if the bones of the leg were broken and the skin remained intact, the surgeon applied the necessary apparatus without any other anxiety than that of maintaining a good position of the fragments, although the internal injury to bones and soft parts might be very severe. If, on the other hand, a wound of the skin was present communicating with the broken bones, although the damage might be in other respects comparatively slight, the compound fracture, as it was termed, was one of the most dangerous accidents that could happen. Mr. Syme, who was, I believe, the safest surgeon of his time, once told me that he was inclined to think that it would be, on the whole, better if all compound fractures of the leg were subjected to amputation, without any attempt to save the limb. What was the cause of this astonishing difference? It was clearly in some way due to the exposure of the injured parts to the external world. One obvious effect of such exposure was indicated by the odour of the discharge, which showed that the blood in the wound had undergone putrefactive change by which the bland nutrient liquid had been converted into highly irritating and poisonous substances. I have seen a man with compound fracture of the leg die within two days of the accident, as plainly poisoned by the products of putrefaction as if he had taken a fatal dose of some potent toxic drug.

An external wound of the soft parts might be healed in one of two ways. If its surfaces were clean cut and could be brought into accurate apposition, it might unite rapidly and painlessly "by the first intention." This, however, was exceptional. Too often the surgeon's efforts to obtain primary union were frustrated: the wound inflamed and the retentive stitches had to be removed, allowing it to gape; and then, as if it had been left open from the first, healing had to be effected in the other way which it is necessary for me briefly to describe. An exposed raw surface became covered in the first instance with a layer of clotted blood or certain of its constituents, which invariably putrefied; and the irritation of the sensitive tissues by the putrid products appeared to me to account sufficiently for the inflammation which always occurred in and around an open wound during the three or four days which elapsed before what were termed "granulations" had been produced. These constituted a coarsely granular coating of very imperfect or embryonic structure, destitute of sensory nerves and prone to throw off matter or pus, rather than absorb, as freshly divided tissues do, the products of putrefaction. The granulations thus formed a beautiful living plaster, which protected the sensitive parts beneath from irritation, and the system generally from poisoning and consequent febrile disturbance. The granulations had other useful properties of which I may mention their tendency to shrink as they grew, thus gradually reducing the dimensions of the sore. Meanwhile another cause of its diminution was in operation. The cells of the epidermis or scarf-skin of the cutaneous margins were perpetually producing a crop of young cells of similar nature, which gradually spread over the granulations till they covered them entirely, and a complete cicatrix or scar was the result. Such was the other mode of healing, that by granulation and cicatrisation; a process which, when it proceeded unchecked to its completion, commanded our profound admiration. It was, however, essentially tedious compared with primary union, while, as we have seen, it was always preceded by more or less inflammation and fever, sometimes very serious in their effects. It was also liable to unforeseen interruptions. The sore might become larger instead of smaller, cicatrisation giving place to ulceration in one of its various forms, or even to the frightful destruction of tissue which, from the circumstance that it was most frequently met with in hospitals, was termed hospital gangrene. Other serious and often fatal complications might arise, which the surgeon could only regard as untoward accidents and over which he had no efficient control.

It will be readily understood from the above description that the inflammation which so often frustrated the surgeon's endeavours after primary union was in my opinion essentially due to decomposition of blood within the wound.

These and many other considerations had long impressed me with the greatness of the evil of putrefaction in surgery. I had done my best to mitigate it by scrupulous ordinary cleanliness and the use of various deodorant lotions. But to prevent it

altogether appeared hopeless while we believed with Liebig that its primary cause was the atmospheric oxygen which, in accordance with the researches of Graham, could not fail to be perpetually diffused through the porous dressings which were used to absorb the blood discharged from the wound. But when Pasteur had shown that putrefaction was a fermentation caused by the growth of microbes, and that these could not arise *de novo* in the decomposable substance, the problem assumed a more hopeful aspect. If the wound could be treated with some substance which, without doing too serious mischief to the human tissues, would kill the microbes already contained in it and prevent the future access of others in the living state, putrefaction might be prevented, however freely the air with its oxygen might enter. I had heard of carbolic acid as having a remarkable deodorising effect upon sewage, and having obtained from my colleague Dr. Anderson, Professor of Chemistry in the University of Glasgow, a sample which he had of this product, then little more than a chemical curiosity in Scotland, I determined to try it in compound fractures. Applying it undiluted to the wound, with an arrangement for its occasional renewal, I had the joy of seeing these formidable injuries follow the same safe and tranquil course as simple fractures, in which the skin remains unbroken.

At the same time we had the intense interest of observing in open wounds what had previously been hidden from human view, the manner in which subcutaneous injuries are repaired. Of special interest was the process by which portions of tissue killed by the violence of the accident were disposed of, as contrasted with what had till then been invariably witnessed. Dead parts had been always seen to be gradually separated from the living by an inflammatory process and thrown off as sloughs. But when protected by the antiseptic dressing from becoming putrid and therefore irritating, a structure deprived of its life caused no disturbance in its vicinity; and, on the contrary, being of a nutritious nature, it served as pabulum for the growing elements of the neighbouring living structures, and these became in due time entirely substituted for it. Even dead bone was seen to be thus replaced by living osseous tissue.

This suggested the idea of using threads of dead animal tissue for tying blood-vessels; and this was realised by means of catgut, which is made from the intestine of the sheep. If deprived of living microbes, and otherwise properly prepared, catgut answers its purpose completely; the knot holding securely, while the ligature around the vessel becomes gradually absorbed and replaced by a ring of living tissue. The threads, instead of being left long as before, could now be cut short, and the tedious process of separation of the ligature, with its attendant serious danger of bleeding, was avoided.

Undiluted carbolic acid is a powerful caustic; and although it might be employed in compound fracture, where some loss of tissue was of little moment in comparison with the tremendous danger to be averted, it was altogether unsuitable for wounds made by the surgeon. It soon appeared, however, that the acid would answer the purpose aimed at, though used in diluted forms devoid of caustic action, and therefore applicable to operative surgery. According to our then existing knowledge, two essential points had to be aimed at: to conduct the operation so that on its completion the wound should contain no living microbes, and to apply a dressing capable of preventing the access of other living organisms till the time should have arrived for changing it.

Carbolic acid lent itself well to both these objects. Our experience with this agent brought out what was, I believe, a new principle in pharmacology—namely, that the energy of action of any substance upon the human tissues depends not only upon the proportion in which it is contained in the material used as a vehicle for its administration, but also upon the degree of tenacity with which it is held by its solvent. Water dissolves carbolic acid sparingly and holds it extremely lightly, leaving it free to act energetically on other things for which it has greater affinity, while various organic substances absorb it greedily and hold it tenaciously. Hence its watery solution seemed admirably suited for a detergent lotion to be used during the operation for destroying any microbes that might fall upon the wound, and for purifying the surrounding skin and also the surgeon's hands and instruments. For the last-named purpose it had the further advantage that it did not act on steel.

For an external dressing the watery solution was not adapted, as it soon lost the acid it contained, and was irritating while it lasted. For this purpose some organic substances were found to answer well. Large proportions of the acid could be blended with them in so bland a form as to be unirritating; and such mixtures, while perpetually giving off enough of the volatile salt to prevent organic development in the discharges that flowed past them, served as a reliable store of the antiseptic for days together.

The appliances which I first used for carrying out the antiseptic principle were both rude and needlessly complicated. The years that have since passed have witnessed great improvements in both respects, of the various materials which have been employed by myself and others, and their modes of application, I need say nothing except to express my belief, as a matter of long experience, that carbolic acid, by virtue of its powerful affinity for the epidermis and oily matters associated with it, and also its great penetrating power, is still the best agent at our disposal for purifying the skin around the wound. But I must say a few words regarding a most important simplification of our procedure. Pasteur, as we have seen, had shown that the air of every inhabited room teems with microbes; and for a long time I employed various more or less elaborate precautions against the living atmospheric dust, not doubting that, as all wounds except the few which healed completely by the first intention underwent putrefactive fermentation, the blood must be a peculiarly favourable soil for the growth of putrefactive microbes. But I afterwards learnt that such was by no means the case. I had performed many experiments in confirmation of Pasteur's germ theory, not indeed in order to satisfy myself of its truth, but in the hope of convincing others. I had observed that uncontaminated milk, which would remain unaltered for an indefinite time if protected from dust, was made to teem with microbes of different kinds by a very brief exposure to the atmosphere, and that the same effect was produced by the addition of a drop of ordinary water. But when I came to experiment with blood drawn with antiseptic precautions into sterilised vessels, I saw to my surprise that it might remain free from microbes in spite of similar access of air or treatment with water. I even found that if very putrid blood was largely diluted with sterilised water, so as to diffuse its microbes widely and wash them of their acrid products, a drop of such dilution added to pure blood might leave it unchanged for days at the temperature of the body, although a trace of the septic liquid undiluted caused intense putrefaction within twenty-four hours. Hence I was led to conclude that it was the grosser forms of septic mischief, rather than microbes in the attenuated condition in which they existed in the atmosphere, that we had to dread in surgical practice. And at the London Medical Congress in 1881, I hinted, when describing the experiments I have alluded to, that it might turn out possible to disregard altogether the atmospheric dust. But greatly as I should have rejoiced at such a simplification of our procedure, if justifiable, I did not then venture to test it in practice. I knew that with the safeguards which we then employed I could ensure the safety of my patients, and I did not dare to imperil it by relaxing them. There is one golden rule for all experiments upon our fellow-men. Let the thing tried be that which, according to our best judgment, is the most likely to promote the welfare of the patient. In other words, Do as you would be done by.

Nine years later, however, at the Berlin Congress in 1890, I was able to bring forward what was, I believe, absolute demonstration of the harmlessness of the atmospheric dust in surgical operations. This conclusion has been justified by subsequent experience: the irritation of the wound by antiseptic irrigation and washing may therefore now be avoided, and nature left quite undisturbed to carry out her best methods of repair, while the surgeon may conduct his operations as simply as in former days, provided always that, deeply impressed with the tremendous importance of his object, and inspiring the same conviction in all his assistants, he vigilantly maintains from first to last, with a care that, once learnt, becomes instinctive, but for the want of which nothing else can compensate, the use of the simple means which will suffice to exclude from the wound the coarser forms of septic impurity.

Even our earlier and ruder methods of carrying out the antiseptic principle soon produced a wonderful change in my surgical wards in the Glasgow Royal Infirmary, which, from being some of the most unhealthy in the kingdom, became, as I believe I may say without exaggeration, the healthiest in the world; while other wards, separated from mine only by a passage a few feet broad, where former modes of treatment were for awhile continued, retained their former insalubrity. This result, I need hardly remark, was not in any degree due to special skill on my

part, but simply to the strenuous endeavour to carry out strictly what seemed to me a principle of supreme importance.

Equally striking changes were afterwards witnessed in other institutions. Of these I may give one example. In the great Allgemeines Krankenhaus of Munich, hospital gangrene had become more and more rife from year to year, till at length the frightful condition was reached that 80 per cent. of all wounds became affected by it. It is only just to the memory of Prof. von Nussbaum, then the head of that establishment, to say that he had done his utmost to check this frightful scourge; and that the evil was not caused by anything peculiar in his management was shown by the fact that in a private hospital under his care there was no unusual unhealthiness. The larger institution seemed to have become hopelessly infected, and the city authorities were contemplating its demolition and reconstruction. Under these circumstances, Prof. von Nussbaum despatched his chief assistant, Dr. Lindpaintner, to Edinburgh, where I at that time occupied the chair of Clinical Surgery, to learn the details of the antiseptic system as we then practised it. He remained until he had entirely mastered them, and after his return all the cases were on a certain day dressed on our plan. From that day forward not a single case of hospital gangrene occurred in the Krankenhaus. The fearful disease pyæmia likewise disappeared, and erysipelas soon followed its example.

But it was by no means only in removing the unhealthiness of hospitals that the antiseptic system showed its benefits. Inflammation being suppressed, with attendant pain, fever, and wasting discharge, the sufferings of the patient were, of course, immensely lessened; rapid primary union being now the rule, convalescence was correspondingly curtailed; while as regards safety and the essential nature of the mode of repair, it became a matter of indifference whether the wound had clean-cut surfaces which could be closely approximated, or whether the injury inflicted had been such as to cause destruction of tissue. And operations which had been regarded from time immemorial as unjustifiable were adopted with complete safety.

It pleases me to think that there is an ever-increasing number of practitioners throughout the world to whom this will not appear the language of exaggeration. There are cases in which, from the situation of the part concerned or other unusual circumstances, it is impossible to carry out the antiseptic system completely. These, however, are quite exceptional; and even in them much has been done to mitigate the evil which cannot be altogether avoided.

I ask your indulgence if I have seemed to dwell too long upon matters in which I have been personally concerned. I now gladly return to the labours of others.

The striking results of the application of the germ theory to surgery acted as a powerful stimulus to the investigation of the nature of the micro-organisms concerned; and it soon appeared that putrefaction was by no means the only evil of microbic origin to which wounds were liable. I had myself very early noticed that hospital gangrene was not necessarily attended by any unpleasant odour; and I afterwards made a similar observation regarding the matter formed in a remarkable epidemic of erysipelas in Edinburgh obviously of infective character. I had also seen a careless dressing followed by the occurrence of suppuration without putrefaction. And as these non-putrefactive disorders had the same self-propagating property as ferments, and were suppressed by the same antiseptic agencies which were used for combating the putrefactive microbes, I did not doubt that they were of an analogous origin; and I ventured to express the view that, just as the various fermentations had each its special microbe, so it might be with the various complications of wounds. This surmise was afterwards amply verified. Prof. Ogston, of Aberdeen, was an early worker in this field, and showed that in acute abscesses, that is to say those which run a rapid course, the matter, although often quite free from unpleasant odour, invariably contains micro-organisms belonging to the group which, from the spherical form of their elements, are termed micrococci; and these he classed as streptococci or staphylococci, according as they were arranged in chains or disposed in irregular clusters like bunches of grapes. The German pathologist, Fehleisen, followed with a beautiful research, by which he clearly proved that erysipelas is caused by a streptococcus. A host of earnest workers in different countries have cultivated the new science of Bacteriology, and, while opening up a wide fresh domain of Biology, have demonstrated in so many cases the causal relation between special micro-organisms and special diseases, not only in wounds but in the system generally, as to afford ample confirmation of the induction which had been made by Pasteur that all infective disorders are of microbic origin.

Not that we can look forward with anything like confidence to being able ever to see the *materies morbi* of every disease of this nature. One of the latest of such discoveries has been that by Pfeiffer of Berlin of the bacillus of influenza, perhaps the most minute of all micro-organisms ever yet detected. The bacillus of anthrax, the cause of a plague common among cattle in some parts of Europe, and often communicated to sorters of foreign wool in this country, is a giant as compared with this tiny being; and supposing the microbe of any infectious fever to be as much smaller than the influenza bacillus as this is less than that of anthrax, a by no means unlikely hypothesis, it is probable that it would never be visible to man. The improvements of the microscope, based on the principle established by my father in the earlier part of the century, have apparently nearly reached the limits of what is possible. But that such parasites are really the causes of all this great class of diseases can no longer be doubted.

The first rational step towards the prevention or cure of disease is to know its cause; and it is impossible to overestimate the practical value of researches such as those to which I am now referring. Among their many achievements is what may be fairly regarded as the most important discovery ever made in pathology, because it revealed the true nature of the disease which causes more sickness and death in the human race than any other. It was made by Robert Koch, who greatly distinguished himself when a practitioner in an obscure town in Germany, by the remarkable combination of experimental acuteness and skill, chemical and optical knowledge and successful micro-photography which he brought to bear upon the illustration of infective diseases of wounds in the lower animals; in recognition of which service the enlightened Prussian Government at once appointed him to an official position of great importance in Berlin. There he conducted various important researches; and at the London congress in 1881 he showed to us for the first time the bacillus of tubercle. Wonderful light was thrown by this discovery upon a great group of diseases which had before been rather guessed than known to be of an allied nature; a precision and efficacy never before possible was introduced into their surgical treatment, while the physician became guided by new and sure light as regards their diagnosis and prevention.

At that same London congress Koch demonstrated to us his "plate culture" of bacteria, which was so important, that I must devote a few words to its description. With a view to the successful study of the habits and effects of any particular microbe outside the living body, it is essential that it should be present unmixed in the medium in which it is cultivated. It can be readily understood how difficult it must have been to isolate any particular micro-organism when it existed mixed, as was often the case, with a multitude of other forms. In fact, the various ingenious attempts made to effect this object had often proved entire failures. Koch, however, by an ingenious procedure converted what had been before impossible into a matter of utmost facility. In the broth or other nutrient liquid which was to serve as food for the growing microbe he dissolved, by the aid of heat, just enough gelatine to ensure that, while it should become a solid mass when cold, it should remain fluid though reduced in temperature so much as to be incapable of killing living germs. To the medium thus partially cooled was added some liquid containing, among others, the microbe to be investigated; and the mixture was thoroughly shaken so as to diffuse the bacteria and separate them from each other. Some of the liquid was then poured out in a thin layer upon a glass plate and allowed to cool so as to assume the solid form. The various microbes, fixed in the gelatine and so prevented from intermingling, proceeded to develop each its special progeny, which in course of time showed itself as an opaque speck in the transparent film. Any one of such specks could now be removed and transferred to another vessel in which the microbe composing it grew in perfect isolation.

Pasteur was present at this demonstration, and expressed his sense of the great progress effected by the new method. It was soon introduced into his own institute and other laboratories throughout the world; and it has immensely facilitated bacteriological study.

One fruit of it in Koch's own hands was the discovery of the microbe of cholera in India, whither he went to study the disease. This organism was termed by Koch from its curved

form the "comma bacillus," and by the French the cholera vibrio. Great doubts were for a long time felt regarding this discovery. Several other kinds of bacteria were found of the same shape, some of them producing very similar appearances in culture media. But bacteriologists are now universally agreed that, although various other conditions are necessary to the production of an attack of cholera besides the mere presence of the vibrio, yet it is the essential *materies morbi*; and it is by the aid of the diagnosis which its presence in any case of true cholera enables the bacteriologist to make, that threatened invasions of this awful disease have of late years been so successfully repelled from our shores. If bacteriology had done nothing more for us than this, it might well have earned our gratitude.

I have next to invite your attention to some earlier work of Pasteur. There is a disease known in France under the name of *choléra des poules*, which often produced great havoc among the poultry yards of Paris. It had been observed that the blood of birds that had died of this disease was peopled by a multitude of minute bacteria, not very dissimilar in form and size to the microbe of the lactic ferment to which I have before referred. And Pasteur found that, if this bacterium was cultivated outside the body for a protracted period under certain conditions, it underwent a remarkable diminution of its virulence; so that, if inoculated into a healthy fowl, it no longer caused the death of the bird, as it would have done in its original condition, but produced a milder form of the disease which was not fatal. And this altered character of the microbe, caused by certain conditions, was found to persist in successive generations cultivated in the ordinary way. Thus was discovered the great fact of what Pasteur termed the *atténuation des virus*, which at once gave the clue to understanding what had before been quite mysterious, the difference in virulence of the same disease in different epidemics.

But he made the further very important observation that a bird which had gone through the mild form of the complaint, had acquired immunity against it in its most virulent condition. Pasteur afterwards succeeded in obtaining mitigated varieties of microbes for some other diseases; and he applied with great success the principle which he had discovered in fowl-cholera for protecting the larger domestic animals against the plague of anthrax. The preparations used for such preventive inoculations he termed "vaccins," in honour of our great countryman, Edward Jenner. For Pasteur at once saw the analogy between the immunity to fowl-cholera produced by its attenuated virus, and the protection afforded against small-pox by vaccination. And while pathologists still hesitated, he had no doubt of the correctness of Jenner's expression *variolæ vaccinæ*, or small-pox in the cow.

It is just a hundred years since Jenner made the crucial experiment of inoculating with small-pox a boy whom he had previously vaccinated, the result being, as he anticipated, that the boy was quite unaffected. It may be remarked that this was a perfectly legitimate experiment, involving no danger to the subject of it. Inoculation was at that time the established practice; and if vaccination should prove nugatory, the inoculation would be only what would have been otherwise called for; while it would be perfectly harmless if the hoped-for effect of vaccination had been produced.

We are a practical people, not much addicted to personal commemorations; although our nation did indeed celebrate with fitting splendour the jubilee of the reign of our beloved Queen; and at the invitation of Glasgow the scientific world has lately marked in a manner, though different, as imposing, the jubilee of the life-work of a sovereign in science (Lord Kelvin). But while we cannot be astonished that the centenary of Jenner's immortal discovery should have failed to receive general recognition in this country, it is melancholy to think that this year should, in his native county, have been distinguished by a terrible illustration of the results which would sooner or later inevitably follow the general neglect of his prescriptions.

I have no desire to speak severely of the Gloucester Guardians. They are not sanitary authorities, and had not the technical knowledge necessary to enable them to judge between the teachings of true science and the declamations of misguided, though well-meaning, enthusiasts. They did what they believed to be right; and when roused to a sense of the greatness of their mistake, they did their very best to repair it, so that their city is said to be now the best vaccinated in her Majesty's dominions. But, though by their praiseworthy exertions they succeeded in promptly checking the raging epidemic, they cannot recall the dead to life, or restore beauty to marred features, or sight to blinded eyes. Would that the entire country and our Legislature might take duly to heart this object-lesson!

How completely the medical profession were convinced of the efficacy of vaccination in the early part of this century, was strikingly illustrated by an account given by Prof. Crookshank, in his interesting history of this subject, of several eminent medical men in Edinburgh meeting to see the (to them) unprecedented fact of a vaccinated person having taken small-pox. It has, of course, since become well known that the milder form of the disease, as modified by passing through the cow, confers a less permanent protection than the original human disorder. This it was, of course, impossible for Jenner to foresee. It is, indeed, a question of degree, since a second attack of ordinary small-pox is occasionally known to occur; and vaccination, long after it has ceased to give perfect immunity, greatly modifies the character of the disorder, and diminishes its danger. And, happily, in re-vaccination after a certain number of years we have the means of making Jenner's work complete. I understand that the majority of the Commissioners, who have recently issued their report upon this subject, while recognising the value and importance of re-vaccination, are so impressed with the difficulties that would attend making it compulsory by legislation that they do not recommend that course; although it is advocated by two of their number who are of peculiarly high authority on such a question. I was lately told by a Berlin professor that no serious difficulty is experienced in carrying out the compulsory law that prevails in Germany. The masters of the schools are directed to ascertain in the case of every child attaining the age of twelve whether re-vaccination has been practised. If not, and the parents refuse to have it done, they are fined one mark. If this does not prove effectual, the fine is doubled; and if even the double penalty should not prove efficacious, a second doubling of it would follow; but, as my informant remarked, it is very seldom that it is called for. The result is that small-pox is a matter of extreme rarity in that country, while it is absolutely unknown in the huge German army, in consequence of the rule that every soldier is re-vaccinated on entering the service. Whatever view our Legislature may take on this question, one thing seems to me clear: that it will be the duty of Government to encourage by every available means the use of calf lymph, so as to exclude the possibility of the communication of any human disease to the child, and to institute such efficient inspection of vaccination institutes as shall ensure careful antiseptic arrangements, and so prevent contamination by extraneous microbes. If this were done, "conscientious objections" would cease to have any rational basis. At the same time, the administration of the regulations on vaccination should be transferred (as advised by the Commissioners) to competent sanitary authorities.

But to return to Pasteur. In 1880 he entered upon the study of that terrible but then most obscure disease, hydrophobia or rabies, which from its infective character he was sure must be of microbic origin, although no micro-organism could be detected in it. He early demonstrated the new pathological fact that the virus had its essential seat in the nervous system. This proved the key to his success in this subject. One result that flowed from it has been the cause of unspeakable consolation to many. The foolish practice is still too prevalent of killing the dog that has bitten any one, on the absurd notion that, if it were mad, its destruction would prevent the occurrence of hydrophobia in the person bitten. The idea of the bare possibility of the animal having been so affected causes an agony of suspense during the long weeks or months of possible incubation of the disease. Very serious nervous symptoms aping true hydrophobia have been known to result from the terror thus inspired. Pasteur showed that if a little of the brain or spinal cord of a dog that had been really mad was inoculated in an appropriate manner into a rabbit, it infallibly caused rabies in that animal in a few days. If, therefore, such an experiment was made with a negative result, the conclusion might be drawn with certainty that the dog had been healthy. It is perhaps right that I should say that the inoculation is painlessly done under an anæsthetic, and that in the rabbit rabies does not assume the violent form that it does in the dog, but produces gradual loss of power with little if any suffering.

This is the more satisfactory because rabbits in which the disease has been thus artificially induced are employed in carrying out what was Pasteur's greatest triumph, the preventive

treatment of hydrophobia in the human subject. We have seen that Pasteur discovered that microbes might under some circumstances undergo mitigation of their virulence. He afterwards found that under different conditions they might have it exalted, or, as he expressed it, there might be a *renforcement du virus*. Such proved to be the case with rabies in the rabbit; so that the spinal cords of animals which had died of it contained the poison in a highly intensified condition. But he also found that if such a highly virulent cord was suspended under strict antiseptic precautions in a dry atmosphere at a certain temperature, it gradually from day to day lost in potency, till in course of time it became absolutely inert. If now an emulsion of such a harmless cord was introduced under the skin of an animal, as in the subcutaneous administration of morphia, it might be followed without harm another day by a similar dose of a cord still rather poisonous; and so from day to day stronger and stronger injections might be used, the system becoming gradually accustomed to the poison, till a degree of virulence had been reached far exceeding that of the bite of a mad dog. When this had been attained, the animal proved incapable of taking the disease in the ordinary way; and more than that, if such treatment was adopted after an animal had already received the poison, provided that too long a time had not elapsed, the outbreak of the disease was prevented. It was only after great searching of heart that Pasteur, after consultation with some trusted medical friends, ventured upon trying this practice upon man. It has since been extensively adopted in various parts of the world with increasing success as the details of the method were improved. It is not of course the case that every one bitten by a really rabid animal takes the disease; but the percentage of those who do so, which was formerly large, has been reduced almost to zero by this treatment, if not too long delayed.

While the intensity of rabies in the rabbit is undoubtedly due to a peculiarly virulent form of the microbe concerned, we cannot suppose that the daily diminishing potency of the cord suspended in dry warm air is an instance of attenuation of virus, using the term "virus" as synonymous with the microbe concerned. In other words, we have no reason to believe that the special micro-organism of hydrophobia continues to develop in the dead cord and produce successively a milder and milder progeny, since rabies cannot be cultivated in the nervous system of a dead animal. We must rather conclude that there must be some chemical poison present which gradually loses its potency as time passes. And this leads me to refer to another most important branch of this large subject of bacteriology, that of the poisonous products of microbes.

It was shown several years ago by Roux and Yersin, working in the Institut Pasteur, that the crust or false membrane which forms upon the throats of patients affected with diphtheria contains bacteria which can be cultivated outside the body in a nutrient liquid, with the result that it acquires poisonous qualities of astonishing intensity, comparable to that of the secretion of the poison-glands of the most venomous serpents. And they also ascertained that the liquid retained this property after the microbes had been removed from it by filtration, which proved that the poison must be a chemical substance in solution, as distinguished from the living element which had produced it. These poisonous products of bacteria, or toxins as they have been termed, explain the deadly effects of some microbes, which it would otherwise be impossible to understand. Thus, in diphtheria itself the special bacillus which was shown by Löffler to be its cause, does not become propagated in the blood, like the microbe of chicken cholera, but remains confined to the surface on which it first appeared; but the toxin which it secretes is absorbed from that surface into the blood, and so poisons the system. Similar observations have been made with regard to the microbes of some other diseases, as, for example, the bacillus of tetanus or lockjaw. This remains localised in the wound, but forms a special toxin of extreme potency, which becomes absorbed and diffused through the body.

Wonderful as it seems, each poisonous microbe appears to form its own peculiar toxin. Koch's tuberculin was of this nature, a product of the growth of the tubercle bacillus in culture media. Here, again, great effects were produced by extremely minute quantities of the substance, but here a new peculiarity showed itself, viz. that patients affected with tubercular disease, in any of its varied forms, exhibited inflammation in the affected part and general fever after receiving under the skin an amount of the material which had no effect whatever upon healthy persons. I witnessed in Berlin some instances of these effects, which were simply astounding. Patients affected with a peculiar form of obstinate ulcer of the face showed, after a single injection of the tuberculin, violent inflammatory redness and swelling of the sore and surrounding skin; and, what was equally surprising, when this disturbance subsided the disease was found to have undergone great improvement. By repetitions of such procedures, ulcers which had previously been steadily advancing, in spite of ordinary treatment, became greatly reduced in size, and in some instances apparently cured. Such results led Koch to believe that he had obtained an effectual means of dealing with tnbercular disease in all its forms. Unhappily, the apparent cure proved to be only of transient duration, and the high hopes which had been inspired by Koch's great reputation was dashed. It is but fair to say that he was strongly urged to publish before he was himself disposed to do, and we cannot but regret that he yielded to the pressure put upon him.

But though Koch's sanguine anticipations were not realised, it would be a great mistake to suppose that his labours with tuberculin have been fruitless. Cattle are liable to tubercle, and, when affected with it, may become a very serious source of infection for human beings, more especially when the disease affects the udders of cows, and so contaminates the milk. By virtue of the close affinity that prevails between the lower animals and ourselves, in disease as well as in health, tuberculin produces fever in tubercular cows in doses which do not affect healthy beasts. Thus, by the subcutaneous use of a little of the fluid, tubercle latent in internal organs of an apparently healthy cow can be with certainty revealed, and the slaughter of the animal after this discovery protects man from infection.

It has been ascertained that glanders presents a precise analogy with tubercle as regards the effects of its toxic product. If the microbe which has been found to be the cause of this disease is cultivated in appropriate media, it produces a poison which has received the name of mallein, and the subcutaneous injection of a suitable dose of this fluid into a glandered horse causes striking febrile symptoms which do not occur in a healthy animal. Glanders, like tubercle, may exist in insidious latent forms which there was formerly no means of detecting, but which are at once disclosed by this means. If a glandered horse has been accidentally introduced into a large stable, this method of diagnosis surely tells if it has infected others. All receive a little mallein. Those which become affected with fever are slaughtered, and thus not only is the disease prevented from spreading to other horses, but the grooms are protected from a mortal disorder.

This valuable resource sprang from Koch's work on tuberculin, which has also indirectly done good in other ways. His distinguished pupil, Behring, has expressly attributed to those researches the inspiration of the work which led him and his since famous collaborateur, the Japanese Kitasato, to their surprising discovery of anti-toxic serum. They found that if an animal of a species liable to diphtheria or tetanus received a quantity of the respective toxin, so small as to be harmless, and afterwards, at suitable intervals, successively stronger and stronger doses, the creature, in course of time, acquired such a tolerance for the poison as to be able to receive with impunity a quantity very much greater than would at the outset have proved fatal. So far, we have nothing more than seems to correspond with the effects of the increasingly potent cord in Pasteur's treatment of rabies. But what was entirely new in their results was that, if blood was drawn from an animal which had acquired this high degree of artificial immunity, and some of the clear fluid or serum which exuded from it after it had clotted was introduced under the skin of another animal, this second animal acquired a strong, though more transient, immunity against the particular toxin concerned. The serum in some way counteracted the toxin or was antitoxic. But, more than that, if some of the antitoxic serum was applied to an animal after it had already received a poisonous dose of the toxin, it preserved the life of the creature, provided that too long a time had not elapsed after the poison was introduced. In other words, the antitoxin proved to be not only preventive but curative.

Similar results were afterwards obtained by Ehrlich, of Berlin, with some poisons not of bacterial origin, but derived from the vegetable kingdom; and quite recently the independent labours of Calmette of Lille and Fraser of Edinburgh have shown that antidotes of wonderful efficacy against the venom of serpents may be procured on the same principle. Calmette has obtained

antitoxin so powerful that a quantity of it only a 200,000th part of the weight of an animal will protect it perfectly against a dose of the secretion of the poison glands of the most venomous serpents known to exist, which without such protection would have proved fatal in four hours. For curative purposes larger quantities of the remedy are required, but cases have been already published by Calmette in which death appears to have been averted in the human subject by this treatment.

Behring's darling object was to discover means of curing tetanus and diphtheria in man. In tetanus the conditions are not favourable; because the specific bacilli lurk in the depths of the wound, and only declare their presence by symptoms caused by their toxin having been already in a greater or less amount diffused through the system; and in every case of this disease there must be a fear that the antidote may be applied too late to be useful. But in diphtheria the bacilli very early manifest their presence by the false membrane which they cause upon the throat, so that the antitoxin has a fair chance; and here we are justified in saying that Behring's object has been attained.

The problem, however, was by no means so simple as in the case of some mere chemical poison. However effectual the antitoxin might be against the toxin, if it left the bacilli intact, not only would repeated injections be required to maintain the transient immunity to the poison perpetually secreted by the microbes, but the bacilli might by their growth and extension cause obstruction of the respiratory passages.

Roux, however, whose name must always be mentioned with honour in relation to this subject, effectually disposed of this difficulty. He showed by experiments on animals that a diphtheritic false membrane, rapidly extending and accompanied by surrounding inflammation, was brought to a stand by the use of the antitoxin, and soon dropped off, leaving a healthy surface. Whatever be the explanation, the fact was thus established that the antitoxic serum, while it renders the toxin harmless, causes the microbe to languish and disappear.

No theoretical objection could now be urged against the treatment; and it has during the last two years been extensively tested in practice in various parts of the world, and it has gradually made its way more and more into the confidence of the profession. One important piece of evidence in its favour in this country is derived from the report of the six large hospitals under the management of the London Asylums Board. The medical officers of these hospitals at first naturally regarded the practice with scepticism; but as it appeared to be at least harmless, they gave it a trial; and during the year 1895 it was very generally employed upon the 2182 cases admitted; and they have all become convinced of its great value. In the nature of things, if the theory of the treatment is correct, the best results must be obtained when the patients are admitted at an early stage of the attack, before there has been time for much poisoning of the system; and accordingly we learn from the report that, comparing 1895 with 1894, during which latter year the ordinary treatment had been used, the percentage of mortality, in all the six hospitals combined, among the patients admitted on the first day of the disease, which in 1894 was 22·5, was only 4·6 in 1895; while for those admitted on the second day the numbers are 27 for 1894 and 14·8 for 1895. Thus for cases admitted on the first day the mortality was only one-fifth of what it was in the previous year, and for those entering on the second it was halved. Unfortunately, in the low parts of London, which furnish most of these patients, the parents too often delay sending in the children till much later: so that on the average no less than 67·5 per cent. were admitted on the fourth day of the disease or later. Hence the aggregate statistics of all cases are not nearly so striking. Nevertheless, taking it altogether, the mortality in 1895 was less than had ever before been experienced in those hospitals. I should add that there was no reason to think that the disease was of a milder type than usual in 1895; and no change whatever was made in the treatment except as regards the antitoxic injections.

There is one piece of evidence recorded in the report which, though it is not concerned with high numbers, is well worthy of notice. It relates to a special institution to which convalescents from scarlet fever are sent from all the six hospitals. Such patients occasionally contract diphtheria, and when they do so the added disease has generally proved extremely fatal. In the five years preceding the introduction of the treatment with antitoxin the mortality from this cause had never been less than 50 per cent., and averaged on the whole 61·9 per cent. During 1895, under antitoxin, the deaths among the 119 patients of this class were only 7·5 per cent., or one-eighth of what had been previously experienced. This very striking result seems to be naturally explained by the fact that these patients being already in hospital when the diphtheria appeared, an unusually early opportunity was afforded for dealing with it.

There are certain cases of so malignant a character from the first that no treatment will probably ever be able to cope with them. But taking all cases together it seems probable that Behring's hope that the mortality may be reduced to 5 per cent. will be fully realised when the public become alive to the paramount importance of having the treatment commenced at the outset of the disease

There are many able workers in the field of Bacteriology whose names time does not permit me to mention, and to whose important labours I cannot refer; and even those researches of which I have spoken have been, of course, most inadequately dealt with. I feel this especially with regard to Pasteur, whose work shines out more brightly the more his writings are perused.

I have lastly to bring before you a subject which, though not bacteriological, has intimate relations with bacteria. If a drop of blood is drawn from the finger by a prick with a needle and examined microscopically between two plates of glass, there are seen in it minute solid elements of two kinds, the one pale orange bi-concave discs, which, seen in mass, give the red colour to the vital fluid, the other more or less granular spherical masses of the soft material called protoplasm, destitute of colour, and therefore called the colourless or white corpuscles. It has been long known that if the microscope was placed at such a distance from a fire as to have the temperature of the human body, the white corpuscles might be seen to put out and retract little processes or pseudopodia, and by their means crawl over the surface of the glass, just like the extremely low forms of animal life termed, from this faculty of changing their form, amœbæ. It was a somewhat weird spectacle, that of seeing what had just before been constituents of our own blood moving about like independent creatures. Yet there was nothing in this inconsistent with what we knew of the fixed components of the animal frame. For example, the surface of a frog's tongue is covered with a layer of cells, each of which is provided with two or more lashing filaments or cilia, and those of all the cells acting in concert cause a constant flow of fluid in a definite direction over the organ. If we gently scrape the surface of the animal's tongue, we can detach some of these ciliated cells; and on examining them with the microscope in a drop of water, we find that they will continue for an indefinite time their lashing movements, which are just as much living or vital in their character as the writhings of a worm. And as I observed many years ago, these detached cells behave under the influence of a stimulus just like parts connected with the body, the movements of the cilia being excited to greater activity by gentle stimulation, and thrown into a state of temporary inactivity when the irritation was more severe. Thus each constituent element of our bodies may be regarded as in one sense an independent living being, though all work together in marvellous harmony for the good of the body politic. The independent movements of the white corpuscles outside the body were therefore not astonishing; but they long remained matters of mere curiosity. Much interest was called to them by the observation of the German pathologist Cohnheim that in some inflammatory conditions they passed through the pores in the walls of the finest blood-vessels, and thus escaped into the interstices of the surrounding tissues. Cohnheim attributed their transit to the pressure of the blood. But why it was that, though larger than the red corpuscles, and containing a nucleus which the red ones have not, they alone passed through the pores of the vessels, or why it was that this emigration of the white corpuscles occurred abundantly in some inflammations and was absent in others, was quite unexplained.

These white corpuscles, however, have been invested with extraordinary new interest by the researches of the Russian naturalist and pathologist, Metchnikoff. He observed that, after passing through the walls of the vessels, they not only crawl about like amœbæ, but, like them, receive nutritious materials into their soft bodies and digest them. It is thus that the effete materials of a tadpole's tail are got rid of; so that they play a most important part in the function of absorption.

But still more interesting observations followed. He found

that a microscopic crustacean, a kind of water-flea, was liable to be infested by a fungus which had exceedingly sharp-pointed spores. These were apt to penetrate the coats of the creature's intestine, and project into its body cavity. No sooner did this occur with any spore than it became surrounded by a group of the cells which are contained in the cavity of the body and correspond to the white corpuscles of our blood. These proceeded to attempt to devour the spore; and if they succeeded, in every such case the animal was saved from the invasion of the parasite. But if the spores were more than could be disposed of by the devouring cells (phagocytes, as Metchnikoff termed them), the water-flea succumbed.

Starting from this fundamental observation, he ascertained that the microbes of infective diseases are subject to this same process of devouring and digestion, carried on both by the white corpuscles and by cells that line the blood-vessels. And by a long series of most beautiful researches he has, as it appears to me, firmly established the great truth that phagocytosis is the main defensive means possessed by the living body against the invasions of its microscopic foes. The power of the system to produce antitoxic substances to counteract the poisons of microbes is undoubtedly in its own place of great importance. But in the large class of cases in which animals are naturally refractory to particular infective diseases the blood is not found to yield any antitoxic element by which the natural immunity can be accounted for. Here phagocytosis seems to be the sole defensive agency. And even in cases in which the serum does possess antitoxic, or, as it would seem in some cases, germicidal properties, the bodies of the dead microbes must at last be got rid of by phagocytosis, and some recent observations would seem to indicate that the useful elements of the serum may be, in part at least, derived from the digestive juices of the phagocytes. If ever there was a romantic chapter in pathology, it has surely been that of the story of phagocytosis.

I was myself peculiarly interested by these observations of Metchnikoff's, because they seemed to me to afford clear explanation of the healing of wounds by first intention under circumstances before incomprehensible. This primary union was sometimes seen to take place in wounds treated with water-dressing—that is to say, a piece of wet lint covered with a layer of oiled-silk to keep it moist. This, though cleanly when applied, was invariably putrid within twenty-four hours. The layer of blood between the cut surfaces was thus exposed at the outlet of the wound to a most potent septic focus. How was it prevented from putrefying, as it would have done under such influence if, instead of being between divided living tissues, it had been between plates of glass or other indifferent material? Pasteur's observations pushed the question a step further. It now was, How were the bacteria of putrefaction kept from propagating in the decomposable film? Metchnikoff's phagocytosis supplied the answer. The blood between the lips of the wound became rapidly peopled with phagocytes, which kept guard against the putrefactive microbes, and seized them as they endeavoured to enter.

If phagocytosis was ever able to cope with septic microbes in so concentrated and intense a form, it could hardly fail to deal effectually with them in the very mitigated condition in which they are present in the air. We are thus strongly confirmed in our conclusion that the atmospheric dust may safely be disregarded in our operations; and Metchnikoff's researches, while they have illumined the whole pathology of infective diseases, have beautifully completed the theory of antiseptic treatment in surgery.

I might have taken equally striking illustrations of my theme from other departments in which microbes play no part. In fact, any attempt to speak of all that the art of healing has borrowed from science and contributed to it during the past half-century, would involve a very extensive dissertation on pathology and therapeutics. I have culled specimens from a wide field; and I only hope that in bringing them before you I have not overstepped the bounds of what is fitting before a mixed company. For many of you my remarks can have had little, if any, novelty; for others they may perhaps possess some interest as showing that Medicine is no unworthy ally of the British Association; that, while her practice is ever more and more based on science, the ceaseless efforts of her votaries to improve what has been fittingly designated *Quæ prosunt omnibus artes*, are ever adding largely to the sum of abstract knowledge.

SECTION A.

MATHEMATICS AND PHYSICS.

OPENING ADDRESS BY PROF. J. J. THOMSON, F.R.S., PRESIDENT OF THE SECTION.

THERE is a melancholy reminiscence connected with this meeting of our Section, for when the British Association last met in Liverpool the chair in Section A was occupied by Clerk-Maxwell. In the quarter of a century which has elapsed since that meeting, one of the most important advances made in our science has been the researches which, inspired by Maxwell's view of electrical action, confirmed that view, and revolutionised our conception of the processes occurring in the Electro-magnetic field. When the Association last met in Liverpool Maxwell's view was almost without supporters, to-day its opponents are fewer than its supporters then. Maxwell's theory, which is the development and extension of Faraday's, has not only affected our way of regarding the older phenomena of electricity, it has, in the hands of Hertz and others, led to the discovery of whole regions of phenomena previously undreamt of. It is sad to think that his premature death prevented him from reaping the harvest he had sown. His writings are, however, with us, and are a storehouse to which we continually turn, and never, I think, without finding something valuable and suggestive.

> "Thus ye teach us day by day,
> Wisdom, though now far away."

The past year has been rich in matters of interest to physicists. In it has occurred the jubilee of Lord Kelvin's tenure of the Professorship of Natural Philosophy at the University of Glasgow. Some of us were privileged to see this year at Glasgow an event unprecedented in the history of physical science in England, when congratulations to Lord Kelvin on the jubilee of his professorship were offered by people of every condition and country. Every scientific society and every scientific man is Lord Kelvin's debtor; but no society and no body of men owe him a greater debt than Section A of the British Association; he has done more for this Section than any one else, he has rarely missed its meetings, he has contributed to the Section papers which will make its proceedings imperishable, and by his enthusiasm he has year by year inspired the workers in this Section to renew with increased vigour their struggles to penetrate the secrets of nature. Long may we continue to receive from him the encouragement and assistance which have been so freely given for the past half-century.

By the death of Sir W. R. Grove, the inventor of Grove's cell, we have lost a physicist whose name is a familiar one in every laboratory in the world. Besides the Grove cell, we owe to him the discovery of the gas battery, and a series of researches on the electrical behaviour of gases, whose importance is only now beginning to be appreciated. His essay on the correlation of the physical forces had great influence in promoting that belief in the unity of the various branches of physics which is one of the characteristic features of modern natural philosophy.

In the late Prof. Stoletow, of Moscow, we have lost the author of a series of most interesting researches on the electrical properties of gases illuminated by ultra-violet light, researches which, from their place of publication, are, I am afraid, not so well known in this country as they deserve to be.

As one who unfortunately of late years has had only too many opportunities of judging of the teaching of science in our public and secondary schools, I should like to bear testimony to the great improvement which has taken place in the teaching of physics in these schools during the past ten years. The standard attained in physics by the pupils of these schools is increasing year by year, and great credit is due to those by whose labours this improvement has been accomplished. I hope I may not be considered ungrateful if I express the opinion that in the zeal and energy which is now spent in the teaching of physics in schools, there may lurk a temptation to make the pupils cover too much ground. You may by careful organisation and arrangement ensure that boys shall be taken over many branches of physics in the course of a short time; it is indeed not uncommon to find boys of seventeen or eighteen who have compassed almost the whole range of physical subjects. But although you may increase the rate at which information is acquired, you cannot increase in anything like the same proportion the rate at which the subject is assimilated, so as to become a means of strengthening the mind and a permanent mental endowment when the facts have long been forgotten.

Physics can be taught so as to be a subject of the greatest possible educational value, but when it is so it is not so much because the student acquires a knowledge of a number of interesting and important facts, as by the mental training the study affords in, as Maxwell said, "bringing out theoretical knowledge to bear on the objects and the objects on our theoretical knowledge." I think this training can be got better by going very slowly through such a subject as mechanics, making the students try innumerable experiments of the simplest and, what is a matter of importance in school teaching, of the most inexpensive kind, but always endeavouring to arrive at numerical results, rather than by attempting to cover the whole range of mechanics, light, heat, sound, electricity, and magnetism. I confess I regret the presence in examinations intended for school boys of many of these subjects.

I think, too, that in the teaching of physics at our universities, there is perhaps a tendency to make the course too complex and too complete. I refer especially to the training of those students who intend to become physicists. I think that after a student has been trained to take accurate observations, to be alive to those pitfalls and errors to which all experiments are liable, mischief may in some cases be done if, with the view of learning a knowledge of methods, he is kept performing elaborate experiments, the results of which are well known. It is not given to many to wear a load of learning lightly as a flower. With many students a load of learning, especially if it takes a long time to acquire, is apt to crush enthusiasm. Now, there is, I think, hardly any quality more essential to success in physical investigations than enthusiasm. Any investigation in experimental physics requires a large expenditure of both time and patience; the apparatus seldom, if ever, begins by behaving as it ought; there are times when all the forces of nature, all the properties of matter, seem to be fighting against us; the instruments behave in the most capricious way, and we appreciate Coutts Trotter's saying, that the doctrine of the constancy of nature could never have been discovered in a laboratory. These difficulties have to be overcome, but it may take weeks or months to do so, and, unless the student is enthusiastic, he is apt to retire disheartened from the contest. I think, therefore, that the preservation of youthful enthusiasm is one of the most important points for consideration in the training of physicists. In my opinion this can best be done by allowing the student, even before he is supposed to be acquainted with the whole of physics, to begin some original research of a simple kind under the guidance of a teacher who will encourage him and assist in the removal of difficulties. If the student once tastes the delights of the successful completion of an investigation, he is not likely to go back, and will be better equipped for investigating the secrets of nature than if, like the White Knight of "Alice in Wonderland," he commences his career knowing how to measure or weigh every physical quantity under the sun, but with little desire or enthusiasm to have anything to do with any of them. Even for those students who intend to devote themselves to other pursuits than physical investigation, the benefits derived from original investigation as a means of general education can hardly be over-estimated, the necessity it entails of independent thought, perseverance in overcoming difficulties, and the weighing of evidence gives it an educational value which can hardly be rivalled. We have to congratulate ourselves that, through the munificence of Mr. Ludwig Mond, in providing and endowing a laboratory for research, the opportunities for pursuing original investigations in this country have been greatly increased.

The discovery at the end of last year by Prof. Röntgen of a new kind of radiation from a highly exhausted tube through which an electric discharge is passing, has aroused an amount of interest unprecedented in the history of physical science. The effects produced *inside* such a tube by the kathode rays, the bright phosphorescence of the glass, the shadows thrown by opaque objects, the deflection of the rays by a magnet, have, thanks to the researches of Crookes and Goldstein, long been familiar to us, but it is only recently that the remarkable effects which occur outside such a tube have been discovered. In 1893, Lenard, using a tube provided with a window made of a very hin plate of aluminium, found that a screen impregnated with a solution of a phosphorescent substance became luminous if placed outside the tube in the prolongation of the line from the kathode through the aluminium window. He also found that photographic plates placed outside the tube in this line were affected, and electrified bodies were discharged; he also obtained by these rays photographs through plates of aluminium or quartz. He found that the rays were affected by a magnet, and regarded them as the prolongations of the kathode rays. This discovery was at the end of last year followed by that of Röntgen, who found that the region round the discharge tube is traversed by rays which affect a photographic plate after passing through substances such as aluminium or cardboard, which are opaque to ordinary light; which pass from one substance to another, without any refraction, and with but little regular reflection; and which are not affected by a magnet. We may, I think, for the purposes of discussion, conveniently divide the rays occurring in or near a vacuum tube traversed by an electric current into three classes, without thereby implying that they are necessarily distinctly different in physical character. We have (1) the kathode rays inside the tube, which are deflected by a magnet; (2) the Lenard rays outside the tube, which are also deflected by a magnet; and (3) the Röntgen rays, which are not, as far as is known, deflected by a magnet. Two views are held as to the nature of the kathode rays; one view is, that they are particles of gas carrying charges of negative electricity, and moving with great velocities which they have acquired as they travelled through the intense electric field which exists in the neighbourhood of the negative electrode. The phosphorescence of the glass is on this view produced by the impact of these rapidly moving charged particles, though whether it is produced by the mechanical violence of the impact, or whether it is due to an electro-magnetic impulse produced by the sudden reversal of the velocity of the negatively charged particle—whether, in fact, it is due to mechanical or electrical causes, is an open question. This view of the constitution of the kathode rays explains in a simple way the deflection of those rays in a magnetic field, and it has lately received strong confirmation from the results of an experiment made by Perrin. Perrin placed inside the exhausted tube a cylindrical metal vessel with a small hole in it, and connected this cylinder with the leaves of a gold-leaf electroscope. The kathode rays could, by means of a magnet, be guided so as either to pass into the cylinder through the aperture, or turned quite away from it. Perrin found that when the kathode rays passed into the cylinder the gold leaf of the electroscope diverged, and had a negative charge, showing that the bundle of kathode rays enclosed by the cylinder had a charge of negative electricity. Crookes had many years ago exposed a disc connected with a gold-leaf electroscope to the bombardment of the kathode rays, and found that the disc received a slight *positive* charge; with this arrangement, however, the charged particles had to give up their charges to the disc if the gold leaves of the electroscope were to be affected, and we know that it is extremely difficult, if not impossible, to get electricity out of a charged gas merely by bringing the gas in contact with a metal. Lord Kelvin's electric strainers are an example of this. It is a feature of Perrin's experiment that since it acts by induction, the indications of the electroscope are independent of the communication of the charges of electricity from the gas to the cylinder, and since the kathode rays fall on the inside of the cylinder, the electroscope would not be affected, even if there were such an effect as is produced when ultra-violet light falls upon the surface of an electro-negative metal when the metal acquires a positive charge. Since any such process cannot affect the total amount of electricity inside the cylinder, it will not affect the gold leaves of the electroscope; in fact, Perrin's experiments prove that the kathode rays carry a charge of negative electricity.

The other view held as to the constitution of the kathode rays is that they are waves in the ether. It would seem difficult to account for the result of Perrin's experiment on this view, and also I think very difficult to account for the magnetic deflection of the rays. Let us take the case of a uniform magnetic field: the experiments which have been made on the magnetic deflection of these rays seem to make it clear that in a magnetic field which is sensibly uniform, the path of these rays is curved; now if these rays were due to ether waves, the curvature of the path would show that the velocity of propagation of these waves varied from point to point of the path. That is, the velocity of propagation of these waves is not only affected by the magnetic field, it is affected differently at different parts of the field. But in a uniform field what is there to differentiate one part from another, so as to account for the variability of the velocity of wave propagation in such a field? The curvature of the path in a uniform field could not be accounted for by supposing that the velocity of this wave motion

depended on the strength of the magnetic field, or that the magnetic field, by distorting the shape of the boundary of the negative dark space, changed the direction of the wave front, and so produced a deflection of the rays. The chief reason for supposing that the kathode rays are a species of wave motion is afforded by Lenard's discovery, that when the kathode rays in a vacuum tube fall on a thin aluminium window in the tube, rays having similar properties are observed on the side of the window outside the tube; this is readily explained on the hypothesis that the rays are a species of wave motion to which the window is partially transparent, while it is not very likely that particles of the gas in the tube could force their way through a piece of metal. This discovery of Lenard's does not, however, seem to me incompatible with the view that the kathode rays are due to negatively charged particles moving with high velocities. The space outside Lenard's tube must have been traversed by Röntgen rays, these would put the surrounding gas in a state in which a current would be readily started in the gas if any electromotive force acted upon it. Now, though the metal window in Lenard's experiments was connected with the earth, and would, therefore, screen off from the outside of the tube any effect arising from slow electrostatic changes in the tube, it does not follow that it would be able to screen off the electrostatic effect of charged particles moving to and from the tube with very great rapidity. For in order to screen off electrostatic effects, there must be a definite distribution of electrification over the screen; changes in this distribution, however, take a finite time, which depends upon the dimensions of the screen and the electrical conductivity of the material of which it is made. If the electrical changes in the tube take place at above a certain rate, the distribution of electricity on the screen will not have time to adjust itself, and the screen will cease to shield off all electrostatic effects. Thus the very rapid electrical changes which would take place if rapidly moving charged bodies were striking against the window, might give rise to electromotive forces in the region outside the window, and produce convection currents in the gas which has been made a conductor by the Röntgen rays. The Lenard rays would thus be analogous in character to the kathode rays, both being convective currents of electricity. Though there are some points in the behaviour of these Lenard rays which do not admit of a very ready explanation from this point of view, yet the difficulties in its way seem to me considerably less than that of supposing that a wave in the ether can change its velocity when moving from point to point in a uniform magnetic field.

I now pass on to the consideration of the Röntgen rays. We are not yet acquainted with any crucial experiment which shows unmistakably that these rays are waves of transverse vibration in the ether, or that they are waves of normal vibration, or indeed that they are vibrations at all. As a working hypothesis, however, it may be worth while considering the question whether there is any property known to be possessed by these rays which is not possessed by some form or other of light. The many forms of light have in the last few months received a noteworthy addition by the discovery of M. Becquerel of an invisible radiation, possessing many of the properties of the Röntgen rays, which is emitted by many fluorescent substances, and to an especially marked extent by the uranium salts. By means of this radiation, which, since it can be polarised, is unquestionably light, photographs through opaque substances similar to, though not so beautiful as, those obtained by means of Röntgen rays, can be taken, and, like the Röntgen rays, they cause an electrified body on which they shine to lose its charge, whether this be positive or negative.

The two respects in which the Röntgen rays differ from light is in the absence of refraction and perhaps of polarisation. Let us consider the absence of refraction first. We know cases in which special rays of the spectrum pass from one substance to another without refraction; for example, Kundt showed that gold, silver, copper allow some rays to pass through them without bending, while other rays are bent in the wrong direction. Pflüger has lately found that the same is true for some of the aniline dyes when in a solid form. In addition to this, the theory of dispersion of light shows that there will be no bending when the frequency of the vibration is very great. I have here a curve taken from a paper by Helmholtz, which shows the relation between the refractive index and the frequency of vibration for a substance whose molecules have a natural period of vibration, and one only; the frequency of this vibration is represented by OK in the diagram. The refractive index increases with the frequency of the light until the latter is equal to the frequency of the natural vibration of the substance; the refractive index then diminishes, becomes less than unity, and finally approaches unity, and is practically equal to it when the frequency of the light greatly exceeds that of the natural vibration of the molecule Helmholtz's results are obtained on the supposition that a molecule of the refracting substance consists of a pair of oppositely electrified atoms, and that the specific inductive capacity of the medium consists of two parts, one due to the ether, the other to the setting of the molecules along the lines of electric force.

Starting from this supposition we can easily see without mathematical analysis that the relation between the refractive index and the frequency must be of the kind indicated by the curve. Let us suppose that an electromotive force of given amplitude acts on this mixture of molecules and ether, and let us start with the frequency of the external electromotive force less than that of the free vibrations of the molecules: as the period of the force approaches that of the molecules, the effect of the force in pulling the molecules into line will increase; thus the specific inductive capacity, and therefore the refractive index increases with the frequency of the external force; the effect of the force on the orientation of the molecules will be greatest when the period of the force coincides with that of the molecules. As long as the frequency of the force is less than that of the molecules, the external field tends to make the molecules set so as to increase the specific inductive capacity of the mixture; as soon, however, as the frequency of the force exceeds that of the molecules, the molecules, if there are no viscous forces, will all topple over and point so as to make the part of the specific inductive capacity due to the molecules of opposite sign to that due to the ether. Thus, for frequencies greater than than of the molecules, the specific inductive capacity will be less than unity. When the frequency of the force only slightly exceeds that of the molecules, the effect of the external field on the molecules is very great, so that if there are a considerable number of molecules, the negative part of the specific inductive capacity due to the molecules may be greater than the positive part due to the ether, so that the specific inductive capacity of the mixture of molecules and ether would be negative; no waves of this period could then travel through the medium, they would be totally reflected from the surface.

As the frequency of the force gets greater and greater, its effect in making the molecules set will get less and less, but the waves will continue to be totally reflected until the negative part of the specific inductive capacity due to the molecules is just equal to the positive part due to the ether. Here the refractive index of the mixture is zero. As the frequency of the force increases, its effect on the molecules gets less and less, so that the specific inductive capacity continually approaches that due to the ether alone, and practically coincides with it as soon as the frequency of the force is a considerable multiple of that of the molecules. In this case both the specific inductive capacity and the refractive index of the medium are the same as that of the ether, and there is consequently no refraction. Thus the absence of refraction, instead of being in contradiction to the Röntgen rays, being a kind of light, is exactly what we should expect if the wave length of the light were exceedingly small.

The other objection to these rays being a kind of light is, that there is no very conclusive evidence of the existence of polarisation. Numerous experiments have been made on the difference between the absorption of these rays by a pair of tourmaline plates when their axes are crossed or parallel. Many observers have failed to observe any difference at all between the absorption in the two cases. Prince Galitzine and M. de Karnojitsky, by a kind of cumulative method, have obtained photographs which seem to show that there is a slightly greater absorption when the axes are crossed than there is when the axes are parallel. There can, however, be no question that the effect, if it exists at all, is exceedingly small compared with the corresponding effect for visible light. Analogy, however, leads us to expect that to get polarisation effects we must use, in the case of short waves, polarisers of a much finer structure than would be necessary for long ones. Thus a wire bird-cage will polarise long electrical waves, but will have no effect on visible light. Rubens and Du Bois made an instrument which would polarise the infra-red rays by winding very fine wires very close together on a framework; this arrangement,

however, was too coarse to polarise visible light. Thus, though the structure of the tourmaline is fine enough to polarise the visible rays, it may be much too coarse to polarise the Röntgen rays if these have exceedingly small wave-lengths. As far as our knowledge of these rays extends, I think we may say that though there is no direct evidence that they are a kind of light, there are no properties of the rays which are not possessed by some variety of light.

It is clear that if the Röntgen rays are light rays, their wave-lengths are of an entirely different order to those of visible light. It is perhaps worth notice that on the electro-magnetic theory of light we might expect two different types of vibration if we suppose that the atoms in the molecule of the vibrating substance carried electrical charges. One set of vibrations would be due to the oscillations of the bodies carrying the charges, the other set to the oscillation of the charges on these bodies. The wave-length of the second set of vibrations would be commensurate with molecular dimensions; Can these vibrations be the Röntgen rays? If so, we should expect them to be damped with such rapidity as to resemble electrical impulses rather than sustained vibrations.

If we turn from the rays themselves to the effect they produce, we find that the rays alter the properties of the substances through which they are passing. This change is most apparent in the effects produced on the electrical properties of the substances. A gas, for example, while transmitting these rays is a conductor of electricity. It retains its conducting properties for some little time after the rays have ceased to pass through it, but Mr. Rutherford and I have lately found that the conductivity is destroyed if a current of electricity is sent through the Röntgenised gas. The gas in this state behaves in this respect like a very dilute solution of an electrolyte. Such a solution would cease to conduct after enough electricity had been sent through it to electrolyse all the molecules of the electrolyte. When a current is passing through a gas exposed to the rays, the current destroys and the rays produce the structure which gives conductivity to the gas; when things have reached a steady state the rate of destruction by the current must equal the rate of production by the rays. The current can thus not exceed a definite value, otherwise more of the conducting gas would be destroyed than is produced.

This explains the very characteristic feature that in the passage of electricity through gases exposed to Röntgen rays, the current, though at first proportional to the electromotive force, soon reaches a value where it is almost constant and independent of the electromotive force, and we get to a state when a tenfold increase in the electromotive force only increases the current by a few per cent. The conductivity under the Röntgen rays varies greatly from one gas to another, the halogens and their gaseous compounds, the compounds of sulphur, and mercury vapour, are among the best conductors. It is worthy of note that those gases which are the best conductors when exposed to the rays are either elements, or compounds of elements, which have in comparison with their valency very high refractive indices.

The conductivity conferred by the rays on a gas is not destroyed by a considerable rise in temperature; it is, for example, not destroyed if it be sucked through metal tubing raised to a red heat. The conductivity is, however, destroyed if the gas is made to bubble through water, it is also destroyed if the gas is forced through a plug of glass wool. This last effect seems to indicate that the structure which confers conductivity on the gas is of a very coarse kind, and we get confirmation of this from the fact that a very thin layer of gas exposed to the Röntgen rays does not conduct nearly so well as a thicker one. I think we have evidence from other sources that electrical conduction is a process that requires a considerable space—a space large enough to enclose a very large number of molecules.

Thus Koller found that the specific resistances of petroleum, turpentine, and distilled water, when determined from experiments made with very thin layers of these substances, was very much larger than when determined from experiments with thicker layers. Even in the case of metals there is evidence that the metal has to be of appreciable size if it is to conduct electricity. The theory of the scattering of light by small particles shows that, if we assume the truth of the electromagnetic theory of light, the effects should be diffeıent according as the small particles are insulators or conductors. When the small particles are non-conductors, theory and experiment concur in showing that the direction of complete polarisation for the scattered light is at right angles to the direction of the incident light, while if the small particles are conductors, theory indicates that the direction of complete polarisation makes an angle of 60° with the incident light. This result is not, however, confirmed by the experiments made by Prof. Threlfall on the scattering of light by very small particles of gold. He found that the gold scattered the light in just the same way as a non-conductor, giving complete polarisation at right angles to the incident light. This would seem to indicate that those very finely divided metallic particles no longer acted as conductors. Thus there seems evidence that in the case of conduction through gases, through badly conducting liquids and through metals, electric conduction is a process which requires a very considerable space and aggregations of large numbers of molecules. I have not been able to find any direct experimental evidence as to whether the same is true for electrolytes. Experiments on the resistance of thin layers of electrolytes would be of considerable interest, as according to one widely-accepted view of electrolysis conduction through electrolytes, so far from being effected by aggregations of molecules, takes place by means of the ion, a structure simpler than that of the molecule, so that if this represents the process of electrolytic conduction, there would not seem room for the occurrence of an effect which occurs with every other kind of conduction.

In this building it is only fitting that some reference should be made to the question of the movement of the ether. You are all doubtless acquainted with the heroic attempts made by Prof. Lodge to set the ether in motion, and how successfully the ether resisted them. It seems to be conclusively proved that a solid body in motion does not set in motion the ether at an appreciable distance outside it; so that if the ether is disturbed at all in such a case, the disturbance is not comparable with that produced by a solid moving through an incompressible fluid, but must be more analogous to that which would be produced by the motion through the liquid of a body of very open structure, such as a piece of wire netting, where the motion of the fluid only extends to a distance comparable with the diameter of the wire, and not with that of the piece of netting. There is another class of phenomena relating to the movement of the ether which is, I think, deserving of consideration, and that is the effect of a varying electro-magnetic field in setting the ether in motion. I do not remember to have seen it pointed out that the electro-magnetic theory of light implicitly assumes that the ether is not set in motion even when acted on by mechanical forces. On the electro-magnetic theory of light such forces do exist, and the equations used are only applicable when the ether is at rest. Consider, for example, the case of a plane electric wave travelling through the ether. We have parallel to the wave-front a varying electric polarisation, which on the theory is equivalent to a current; at right-angles to this, and also in the wave-front, we have a magnetic force. Now, when a current flows through a medium in a magnetic field there is a force acting on the medium at right-angles to the plane, which is parallel both to the current and to the magnetic force; there will thus be a mechanical force acting on each unit volume of the ether when transmitting an electric wave, and since this force is at right-angles to the current and to the magnetic force, it will be in the direction in which the wave is propagated. In the electro-magnetic theory of light, however, we assume that this force does not set the ether in motion, as unless we made this assumption we should have to modify our equations, as the electro-magnetic equations are not the same in a moving field as in a field at rest. In fact, a complete discussion of the transmission of electro-magnetic disturbances requires a knowledge of the constitution of the ether which we do not possess. We now assume that the ether is not set in motion by an electro-magnetic wave. If we do not make this assumption, we must introduce into our equation quantities representing the components of the velocity of the ether, and unless we know the constitution of the ether, so as to be able to deduce these velocities from the forces acting on it, there will be in the equations of the electro-magnetic field more unknown quantities than we have equations to determine. It is, therefore, a very essential point in electro-magnetic theory to investigate whether or not there is any motion of the ether in a varying electro-magnetic field. We have at the Cavendish Laboratory, using Prof. Lodge's arrangement of interference fringes, made some experiments to see if we could detect any movement of the ether in the neighbourhood of an electric vibrator, using the spark which starts the vibrations as the source of light. The movement of the ether, if it exists, will

be oscillatory, and with an undamped vibrator the average velocity would be zero; we used, therefore, a heavily damped vibrator, with which the average velocity might be expected to be finite. The experiments are not complete, but so far the results are entirely negative. We also tried by the same method to see if we could detect any movement of the ether in the neighbourhood of a vacuum-tube emitting Röntgen rays, but could not find any trace of such a movement. Prof. Threlfall, who independently tried the same experiment, has, I believe, arrived at the same conclusion.

Unless the ether is immovable under the mechanical forces in a varying electro-magnetic field, there are a multitude of phenomena awaiting discovery. If the ether does move, then the velocity of transmission of electrical vibrations, and therefore of light, will be affected by a steady magnetic field. Such a field, even if containing nothing but ether, will behave towards light like a crystal, and the velocity of propagation will depend upon the direction of the rays. A similar result would also hold in a steady electric field. We may hope that experiments on these and similar points may throw some light on the properties of that medium which is universal, which plays so large a part in our explanation of physical phenomena, and of which we know so little.

SECTION B.

CHEMISTRY.

OPENING ADDRESS BY DR. LUDWIG MOND, F.R.S., PRESIDENT OF THE SECTION.

IN endeavouring to fix upon a suitable theme for the address I knew you would to-day expect from me, I have felt that I ought to give due consideration to the interests which tie this magnificent city of Liverpool, whose hospitality we enjoy this week, to Section B. of the British Association.

I have therefore chosen to give you a brief history of the manufacture of chlorine, with the progress of which this city and its neighbourhood have been very conspicuously and very honourably connected, not only as regards quantity—I believe this neighbourhood produces to-day nearly as much chlorine as the rest of this world together—but more particularly by having originated, worked out, and carried into practice several of the most important improvements ever introduced into this manufacture. I was confirmed in my choice by the fact that this manufacture has been influenced and perfected in an extraordinary degree by the rapid assimilation and application of the results of purely scientific investigations, and of new scientific theories, and offers a very remarkable example of the incalculable value to our commercial interests of the progress of pure science.

The early history of chlorine is particularly interesting, as it played a most important *rôle* in the development of chemical theories. There can be no doubt that the Arabian alchemist Geber, who lived eleven hundred years ago, must have known that "Aqua Regia," which he prepared by distilling a mixture of salt, nitre, and vitriol, gave off, on heating, very corrosive, evil-smelling, greenish-yellow fumes; and all his followers throughout a thousand years must have been more or less molested by these fumes whenever they used Aqua Regia, the one solvent of the gold they attempted so persistently to produce.

But it was not until 1774 that the great Swedish chemist Scheele succeeded in establishing the character of these fumes. He discovered that on heating manganese with muriatic acid he obtained fumes very similar to those given off by "Aqua Regia," and found that these fumes constituted a permanent gas of yellowish-green colour, very pungent odour, very corrosive, very irritating to the respiratory organs, and which had the power of destroying organic colouring matters.

According to the views prevalent at the time, Scheele considered that the manganese had removed phlogiston from the muriatic acid, and he consequently called the gas dephlogisticated muriatic acid.

When, during the next decade, Lavoisier successfully attacked, and after a memorable struggle completely upset the phlogiston theory, and laid the foundations of our modern chemistry, Berthollet, the eminent "father" of physical chemistry—the science of to-day—endeavoured to determine the place of Scheele's gas in the new theory. Lavoisier was of opinion that all acids, including muriatic acid, contain oxygen. Berthollet found that a solution of Scheele's gas in water, when exposed to the sunlight, gives off oxygen and leaves behind muriatic acid. He considered this as proof that this gas consists of muriatic acid and oxygen, and called it oxygenated muriatic acid.

In the year 1785 Berthollet conceived the idea of utilising the colour-destroying powers of this gas for bleaching purposes. He prepared the gas by heating a mixture of salt, manganese, and vitriol. He used a solution of the gas in water for bleaching, and subsequently discovered that the product obtained by absorbing the gas in a solution of caustic potash possessed great advantages in practice.

This solution was prepared as early as 1789, at the chemical works on the Quai de Javelle, in Paris, and is still made and used there under the name of "Eau de Javelle."

James Watt, whose great mind was not entirely taken up with that greatest of all inventions—his steam-engine—by which he has benefited the human race more than any other man, but who also did excellent work in chemistry—became acquainted in Paris with Berthollet's process, and brought it to Scotland. Here it was taken up with that energy characteristic of the Scotch, and a great stride forward was made when, in 1798, Charles Tennant, the founder of the great firm, which has only recently lapsed into the United Alkali Company, began to use milk of lime in place of the more costly caustic potash, in making a bleaching liquid; and a still greater advance was made when, in the following year, Tennant proposed to absorb the chlorine by hydrate of lime, and thus to produce a dry substance, since known under the name of bleaching powder, which allowed the bleaching powers of chlorine to be transported to any distance.

In order to give you a conception of the theoretical ideas prevalent at this time, I will read to you a passage from an interesting treatise on the art of bleaching published in 1799 by Higgins. In his chapter "On bleaching with the oxygenated muriatic acid, and on the methods of preparing it," he explains the theory of the process as follows:—

"Manganese is an oxyd, a metal saturated with oxygen gas. Common salt is composed of muriatic acid and an alkaline salt called soda, the same which barilla affords. Manganese has greater affinity to sulphuric acid than to its oxygen, and the soda of the salt greater affinity to sulphuric acid than to the muriatic acid gas; hence it necessarily follows that these two gases (or, rather, their gravitating matter) must be liberated from their former union in immediate contact with each other; and although they have but a weak affinity to one another, they unite in their nascent state, that is to say, before they individually unite to caloric, and separately assume the gaseous state; for oxygen gas and muriatic acid gas already formed will not unite when mixed, in consequence principally of the distance at which their respective atmospheres of caloric keep their gravitating particles asunder. The compound resulting from these two gases still retains the property of assuming the gaseous state, and is the oxygenated muriatic gas."

Interesting as these views may appear, considering the time they were published, you will notice that the *rôle* played by the manganese in the process, and the chemical nature of this substance, were not at all understood. The law of multiple proportions had not yet been propounded by John Dalton, and the researches of Berzelius on the oxides of manganese were only published thirteen years later, in 1812. The green gas we are considering was still looked upon as muriatic acid, to which oxygen had been added, in contradistinction to Scheele's view, who considered it as muriatic acid, from which something, viz. phlogiston, had been abstracted.

It was Humphry Davy who had, by a series of brilliant investigations, carried out in the laboratory of the Royal Institution between 1808 and 1810, accumulated fact upon fact to prove that the gas hitherto called oxygenated muriatic acid did not contain oxygen. He announced in an historic paper, which he read before the Royal Society on July 12, 1810, his conclusion that this gas was an elementary body, which in muriatic acid was combined with hydrogen, and for which he proposed the name "chlorine," derived from the Greek χλωρός, signifying "green," the colour by which the gas is distinguished.

The numerous communications which Humphry Davy made to the Royal Society on this subject form one of the brightest and most interesting chapters in the history of chemistry. They have recently been reprinted by the Alembic Society, and I cannot too highly recommend their study to the young students of our science.

Those who have followed the history of chemistry I need not remind how hotly and persistently Davy's views were combated by a number of the most eminent chemists of his time, led by

Berzelius himself; how long the chlorine controversy divided the chemical world; how triumphantly Davy emerged from it; how completely his views were recognised; and how very instrumental they have been in advancing theoretical chemistry.

The hope, however, which Davy expressed in that same historic paper, "that these new views would perhaps facilitate one of the greatest problems in economical chemistry, the decomposition of the muriates of soda and potash," was not to be realised so soon. Although it had changed its name, chlorine was still for many years manufactured by heating a mixture of salt, manganese, and sulphuric acid in leaden stills, as before.

This process leaves a residue consisting of sulphate of soda and sulphate of manganese, and for some time attempts were made to recover the sulphate of soda from these residues, and to use it for the manufacture of carbonate of soda by the Le Blanc process. On the other hand, the Le Blanc process, which had been discovered and put into practice almost simultaneously with Berthollet's chlorine process, decomposed salt by sulphuric acid, and sent the muriatic acid evolved into the atmosphere, causing a great nuisance to the neighbourhood.

Naturally, therefore, when Mr. William Gossage had succeeded in devising plant for condensing this muriatic acid, the manufacturers of chlorine reverted to the original process of Scheele, and heated manganese with the muriatic acid thus obtained. Since then the manufacture of chlorine has become a bye-product of the manufacture of soda by the Le Blanc process, and remained so till very recently.

For a great many years the muriatic acid was allowed to act upon native ores of manganese in closed vessels of earthenware or stone, to which heat could be applied, either externally or internally. These native manganese ores, containing only a certain amount of peroxide, converted only a certain percentage of the muriatic acid employed into free chlorine, the rest combining with the manganese and iron contained in the ore, and forming a brown and very acid solution, which it was a great difficulty for the manufacturer to get rid of. Consequently, many attempts were made to regenerate peroxide of manganese from these waste liquors, so as to use it over again in the production of chlorine.

These, however, for a long time remained unsuccessful, because the exact conditions for super-oxidising the protoxide of manganese by means of atmospheric air were not yet known.

Meantime, viz. in 1845, Mr. Dunlop introduced into the works created by his grandfather, Mr. Charles Tennant, at St. Rollox, a new and very interesting method for producing chlorine, which was in a certain measure a return to the process used by the alchemists.

Indeed, the first part of this process consisted in decomposing a mixture of salt and nitre with oil of vitriol—a reaction that had been made use of for so many centuries! The chlorine so obtained is, however, not pure, but a mixture of chlorine with oxides of nitrogen and hydrochloric acid, which Mr. Dunlop had to find means to eliminate.

For separating the nitrous oxides, Mr. Dunlop adopted the method introduced twenty years before by the great Gay-Lussac in connection with vitriol-making, viz. absorption by sulphuric acid, and the nitro-sulphuric acid thus formed he also utilised in the same way as that obtained from the towers which still bear Gay-Lussac's illustrious name, viz. by using it in the vitriol process in lieu of nitric acid. He then freed his chlorine gas from hydrochloric acid by washing with water, and so obtained it pure. This process possessed two distinct advantages: (1) it yielded a very much larger amount of chlorine from the same amount of salt, and (2) the nitric acid, which was used for oxidising the hydrogen in the hydrochloric acid, was not lost, because the oxides of nitrogen to which it was reduced answered the purpose for which the acid itself had previously been employed. But this process was very limited in its application, as it could only be worked to the extent to which nitric acid was used in vitriol-making.

The process has been at work at St. Rollox for over fifty years, and, as far as I know, is there still in operation; but I am not aware that it has ever been taken up elsewhere.

Within the last few years, however, several serious attempts have been made to give to this process a wider scope by regenerating nitric acid from the nitro-sulphuric acid and employing it over and over again to convert hydrochloric acid into chlorine. Quite a number of patents have been taken out for this purpose, all employing atmospheric air for reconverting the nitrous oxides into nitric acid, and differing mainly in details of apparatus and methods of work, and several of these have been put to practical test on a fairly large scale in this neighbourhood, and also in Glasgow, Middlesbrough, and elsewhere. As I do not want to keep you here the whole afternoon, I have to draw the line somewhere as to what I shall include in this brief history of the manufacture of chlorine, and have had to decide to restrict myself to those methods which have actually attained the rank of manufacturing processes on a large scale. As none of the processes just referred to have attained that position, you will excuse me for not entering into further details respecting them.

Mr. Dunlop's process only produced a very small portion of the chlorine manufactured at that time at St. Rollox, the remainder being made, as before, from native manganese and muriatic acid, leaving behind the very offensive waste liquors I have mentioned before, which increased from year to year, and became more and more difficult to get rid of. The problem of recovering from these liquors the manganese in the form of peroxide Mr. Dunlop succeeded in solving in 1855.

He neutralised the free acid and precipitated the iron present by treating these liquors with ground chalk in the cold and settling out, and in later years, filter-pressing the precipitate, which left him a solution of chloride of manganese, mixed only with chloride of calcium. This was treated with a fresh quantity of milk of chalk, but this time under pressure in closed vessels provided with agitators and heated by steam, under which conditions all the manganese was precipitated as carbonate of manganese. This precipitate was filtered off and well drained, and was then passed on iron trays mounted on carriages through long chambers, in which it was exposed to hot air at a temperature of 300° C., the process being practically made continuous, one tray at the one end being taken out of these chambers, and a fresh tray being put in at the other end. One passage through these chambers sufficed to convert the carbonate of manganese into peroxide, which was used in place of, and in the same way as, the native manganese.

The whole of the residual liquors made at the large works at St. Rollox have been treated by this process with signal success for a long number of years. For a short time the process was discontinued in favour of the Weldon process (of which I have to speak next); but after two years Dunlop's process was taken up again, and, to the best of my knowledge, it is still in operation to this day. It has, however, just like Mr. Dunlop's first chlorine process, never left the place of its birth (St. Rollox), although it was for a period of over ten years without a rival.

In 1866, Mr. Walter Weldon patented a modification of a process proposed by Mr. William Gossage, in 1837, for recovering the manganese that had been used in the manufacture of chlorine. Mr. Gossage had proposed to treat the residual liquors of this manufacture by lime, and to oxidise the resulting protoxide of manganese by bringing it into frequent and intimate contact with atmospheric air. This process—and several modifications thereof subsequently patented—had been tried in various places without success. Mr. Weldon, however, did succeed in obtaining a very satisfactory result, possibly—even probably—because, not being a chemist, he did not add the equivalent quantity of lime to his liquor to precipitate the manganese, but used an excess. However, Mr. Weldon, if he was not a chemist at that time, was a man of genius and of great perseverance. He soon made himself a chemist, and having once got a satisfactory result, he studied every small detail of the reaction with the utmost tenacity until he had thoroughly established how this satisfactory result could be obtained on the largest scale with the greatest regularity and certainty.

He even went further, and added considerably to our theoretical knowledge of the character of manganese peroxide and similar peroxides by putting forward the view that these compounds possess the character of weak acids. He explained in this way the necessity for the presence of an excess of lime or other base if the oxidation of the precipitated protoxide of manganese by means of atmospheric air was to proceed at a sufficiently rapid rate. He pointed out that the product had to be considered as a manganite of calcium, a view which has since been thoroughly proved by the investigations of Goergen and others; and it is only fair to state that Weldon's process is not only a process for recovering the peroxide of manganese originally used, but that he introduced a new substance, viz. manganite of calcium, to be continuously used over and over again in the manufacture of chlorine.

Mr. Weldon had the good fortune that his ideas were taken

up with fervency by Colonel Gamble of St. Helens, and that Colonel Gamble's manager, Mr. F. Bramwell, placed all his experience as a consummate technical chemist and engineer at Mr. Weldon's disposal, and assisted him in carrying his ideas into practice. The result was that a process which many able men had tried in vain to realise for thirty years became in the hands of Mr. Weldon and his coadjutors within a few years one of the greatest successes achieved in manufacturing chemistry.

The Weldon process commences by treating the residual liquor with ground chalk or limestone, thus neutralising the free acid and precipitating any sulphuric acid and oxide of iron present. The clarified liquor is run into a tall cylindrical vessel, and milk of lime is added in sufficient quantity to precipitate all the manganese in the form of protoxide. An additional quantity of milk of lime, from one-fifth to one-third of the quantity previously used, is then introduced, and air passed through the vessel by means of an air-compressor. After a few hours all the manganese is converted into peroxide; the contents of the vessel are then run off; the mud, now everywhere known as "Weldon mud," is settled, and the clear liquor run to waste. The mud is then pumped into large closed stone stills, where it meets with muriatic acid, chlorine is given off, and the residual liquor treated as before.

You note that this process works without any manipulation, merely by the circulation of liquids and thick magmas which are moved by pumping machinery. As compared to older processes it also has the great advantage that it requires very little time for completing the cycle of operations, so that large quantities of chlorine can be produced by a very simple and inexpensive plant. These advantages secured for this process the quite unprecedented success that within a few years it was adopted, with a few isolated exceptions, by every large manufacturer of chlorine in the world; yet it possessed a distinct drawback, viz. that it produced considerably less chlorine from a given quantity of muriatic acid than either native manganese of good quality or Mr. Dunlop's recovered manganese. At that time, however, muriatic acid was produced as a bye-product of the Le Blanc process so largely in excess of what could be utilised that it was generally looked upon as a waste product of no value. Mr. Weldon himself was one of the very few who foresaw that this state of things could not always continue. The ammonia soda process was casting its shadow before it. Patented in 1838 by Messrs. Dyar and Hemming it was only after the lapse of thirty years (during which a number of manufacturing chemists of the highest standing had in vain endeavoured to carry it into practice) that this process was raised to the rank of a manufacturing process through the indomitable perseverance of Mr. Earnest Solvay of Brussels, and his clear perception of its practical and theoretical intricacies. A few years later, in 1872, Mr. Weldon already gave his attention to the problem of obtaining the chlorine of the salt used in this process in the form of muriatic acid. He proposed to recover the ammonia from the ammonium chloride obtained in this manufacture by magnesia instead of lime, thus obtaining magnesium chloride instead of calcium chloride, and to produce muriatic acid from this magnesium chloride by a process patented by Clemm in 1863, viz. by evaporating the solution, heating the residue in the presence of steam and condensing the acid vapours given off.

Strange to say, this same method had been patented by Mr. Ernest Solvay within twenty-fours before Mr. Weldon lodged his specification. It has been frequently tried with many modifications, but has never been found practicable. Soon afterwards Mr. Weldon, with the object of reducing the muriatic acid required by his first process, proposed to replace the lime in this process by magnesia, and so to produce a manganite of magnesia. After treating this with muriatic acid and liberating chlorine he proceeded to evaporate the residual liquors to dryness, during which operation all the chlorine they contain would be disengaged as hydrochloric acid and collected in condensers, while the dry residue, after being heated to dull redness in the presence of air, would be reconverted into manganite of magnesia.

This process was made the subject of long and extensive experiments at the works of Messrs. Gamble at St. Helens, but did not realise Mr. Weldon's expectations. It, however, led to some further interesting developments, to which I shall refer later on.

Those of you who were present at the last meeting of the British Association in this city will remember that this Section had the advantage of listening to a paper by Mr. Weldon on his chlorine process, and also to another highly interesting paper by Mr. Henry Deacon, of Widnes, "on a new chlorine process without manganese." And those of you who came with the then President of the Section (Prof. Roscoe) to Widnes to visit the works of Messrs. Gaskell, Deacon, and Co., will well remember that at these works they saw side by side Weldon's process and Deacon's process in operation, and no one present will have forgotten the thoughtful flashing eyes and impressive face of Mr. Deacon when he explained to his visitors the theoretical views he had formed as regards his process.

Mr. Deacon had made a careful study of thermo-chemistry, which had been greatly developed during the preceding decade by the painstaking, accurate, and comprehensive experiments of Julius Thomsen and of Berthelot, and had led the latter to generalisations, which, although not fully accepted by scientific men, have been of immense service to manufacturing chemistry.

Mr. Deacon came to the conclusion that if a mixture of hydrochloric acid with atmospheric air was heated in the presence of a suitable substance capable of initiating the interaction of these two gases by its affinity to both, it would to a very great extent be converted into chlorine with the simultaneous formation of steam, because the formation of steam from oxygen and hydrogen gives rise to the evolution of a considerably larger quantity of heat than the combination of hydrogen and chlorine. Mr. Deacon found that the salts of copper were a very suitable substance for this purpose, and took out a patent for this process in 1868. He entrusted the study of the theoretical and practical problems connected with this process to Dr. Ferdinand Hurter, who carried them out in a manner which will always remain memorable and will never be surpassed, as an example of the application of scientific methods to manufacturing problems, and which soon placed this beautiful and simple process on a sound basis as a manufacturing operation.

In the ordinary course of manufacture the major part—about two-thirds—of the hydrochloric acid is obtained mixed with air and a certain amount of steam, but otherwise very little contaminated. Instead of condensing the muriatic acid from this mixture of gases by bringing it into contact with water, Mr. Deacon passed it through a long series of cooling pipes to condense the steam, which of course absorbed hydrochloric acid, and formed a certain quantity of strong muriatic acid. The mixture of gases was then passed through an iron superheater to raise it to the required temperature, and thence through a mass of broken bricks impregnated with sulphate or chloride of copper contained in a chamber or cylinder called a decomposer, which was protected from loss of heat by being placed in a brick furnace kept sufficiently hot. In this apparatus from 50 to 60 per cent. of the hydrochloric acid in the mixture of gases was burnt to steam and chlorine. In order to separate this chlorine from the steam and the remaining hydrochloric acid the gases were washed with water, and subsequently with sulphuric acid. The mixture now consisted of nitrogen and oxygen, containing about 10 per cent. of chlorine gas, which could be utilised without any difficulty in the manufacture of bleach liquors and chlorate of potash, and which Mr. Deacon also succeeded in using for the manufacture of bleaching powder, by bringing it into contact in specially constructed chambers with large surfaces of hydrate of lime. Within recent years this latter object has been attained in a more expeditious and perfect manner by continuous mechanical apparatus (of which those constructed by Mr. Robert Hasenclever and Dr. Carl Langer have been the most successful), in which the hydrate of lime is transported in a continuous stream by single or double conveyers in an opposite direction to the current of dilute chlorine, and the bleaching powder formed delivered direct into casks, thereby avoiding the intensely disagreeable work of packing this offensive substance by hand.

Mr. Deacon's beautiful and scientific process thus involves still less movement of materials than the very simple process of Mr. Weldon, because in lieu of large volumes of liquids he only moves a current of gas through his apparatus, which requires a minimum of energy. The only raw material used for converting hydrochloric acid into chlorine is atmospheric air, the cheapest of all at our command. The hydrochloric acid which has not been converted into chlorine by the process is all obtained, dissolved in water, as muriatic acid, and is not lost, as in previous processes, but is still available to be converted into chlorine by other methods, or to be used for other purposes.

In spite of these distinct advantages, this process took a long time before it became adopted as widely as it undoubtedly deserved. This was mainly due to the fact that the economy in

the use of muriatic acid which it effected was at the time when the process was brought out, and for many years afterwards, no object to the majority of chlorine manufacturers, who were still producing more of this commodity than they could use. Moreover, there were other reasons. The plant required for this process, although so simple in principle, is very bulky in proportion to the quantity of chlorine produced, and as I have pointed out, the process only succeeded in converting about one-third of the hydrochloric acid produced into chlorine, the remainder being obtained as muriatic acid, which had in most instances to be converted into chlorine by the Weldon process; so that the Deacon process did not constitute an entirely self-contained method for this manufacture. This defect, of small moment as long as muriatic acid was produced in excessive quantities, was only remedied by an invention of Mr. Robert Hasenclever a short number of years ago; when by the rapid development of the ammonia soda process the previously existing state of things had been completely changed, and when, at least on the continent, muriatic acid was no longer an abundant and valueless bye-product, but, on the contrary, the alkali produced by the Le Blanc process had become a bye-product of the manufacture of chlorine. Mr. Hasenclever, in order to make the whole of the muriatic acid he produces available for conversion into chlorine by the Deacon process, introduces the liquid muriatic acid in a continuous stream into hot sulphuric acid contained in a series of stone vessels, through which he passes a current of air. He thus obtains a mixture of hydrochloric acid and air, well adapted for the Deacon process, the water of the muriatic acid remaining with the sulphuric acid, from which it is subsequently eliminated by evaporation. In this way the chlorine in the hydrochloric acid can be almost entirely obtained in its free state by the simplest imaginable means, and with the intervention of no other chemical agent than atmospheric air. Since their introduction the Deacon process has supplanted the Weldon process in nearly all the largest chlorine works in France and Germany, and is now also making very rapid progress in this country.

Mr. Weldon, when he decided to give up his manganite of magnesia process, by no means relaxed his efforts to work out a chlorine process which should utilise the whole of the muriatic acid. While working with manganite of magnesia he found that magnesia alone would answer the purpose without the presence of the peroxide of manganese. He obtained the assistance of M. Pechiney, of Salindres, and in conjunction with him worked out what has become known as the "Weldon-Pechiney" process, which was first patented in 1884.

This process consists in neutralising muriatic acid by magnesia, concentrating the solution to a point at which it does not yet give off any hydrochloric acid, and then mixing into it a fresh quantity of magnesia so as to obtain a solid oxychloride of magnesium. This is broken up into small pieces, which are heated up rapidly to a high temperature without contact with the heating medium, while a current of air is passing through them. The oxychloride of magnesium containing a large quantity of water, this treatment yields a mixture of chlorine and hydrochloric acid with air and steam, the same as the Deacon process, and this is treated in a very similar way to eliminate the steam and the acid from the chlorine. The acid condensed is, of course, treated with a fresh quantity of magnesia, so that the whole of the chlorine which it contains is gradually obtained in the free state.

The rapid heating to a high temperature of the oxychloride of magnesium without contact with the heating medium was an extremely difficult practical problem, which has been solved by M. Pechiney and his able assistant, M. Boulouvard, in a very ingenious and entirely novel way.

They lined a large wrought-iron box with fire-bricks, and built inside of this vertical fire-brick walls with small empty spaces between them, thus forming a number of very narrow chambers, so arranged that they could all be filled from the top of the box, and emptied from the bottom. These chambers they heated to a very high temperature by passing a gas flame through them, thus storing up in the brick walls enough heat to carry out and complete the decomposition of the magnesium oxychloride, with which the chamber was filled when hot enough.

Mr. Weldon himself called this apparatus a "baker's oven," in which trade certainly the same principle has been employed from time immemorial; but to my knowledge it had never before been used in any chemical industry. This process has been at work at M. Pechiney's large alkali works at Salindres, and is now at work in this country at the chlorate of potash works of Messrs. Allbright and Wilson, at Oldbury, a manufacture for which it offers special advantages. Mr. Weldon and M. Pechiney had expected that this process would become specially useful in connection with the ammonia soda process by preparing in the way proposed by Mr. Solvay and Mr. Weldon in 1872 a solution of magnesium chloride as a bye-product of this manufacture; but instead of obtaining muriatic acid from this solution by Clemm's process, to treat it by the new process, so as to obtain the bulk of the chlorine at once in the free state. But M. Pechiney did no more succeed than his predecessors in recovering the ammonia by means of magnesia in a satisfactory way.

Quite recently, however, it has been applied to obtain chlorine in connection with the ammonia soda process by Dr. Pick, of Czakowa, in Austria. He recovers the ammonia, as usual, by means of lime, and converts the solution of chloride of calcium, obtained by a process patented by Mr. Weldon in 1869, viz. by treatment with magnesia and carbonic acid under pressure, into chloride of magnesium with the formation of carbonate of lime. The magnesium chloride solution is then concentrated and treated by the Weldon-Pechiney process.

I have repeatedly referred during this brief history to the great change which has been brought about in the position of chlorine manufacture by the development of the ammonia soda process, and have pointed out that the muriatic acid which for a long time was the bye-product of the Le Blanc process, without value, thereby became gradually its main and most valuable product, while the alkali became its bye-product.

I have told you how, very early in the history of this process, Mr. Solvay and Mr. Weldon proposed means to provide for this contingency, and how Mr. Weldon continued to improve these means until the time of his death. Mr. Solvay, on his part, also followed up the subject with that tenacity and sincerity of purpose which distinguishes him; his endeavours being mainly directed to producing chlorine direct from the chloride of calcium running away from his works by mixing it with clay and passing air through the mixture at very high temperatures, thus producing chlorine and a silicate of calcium, which could be utilised in cement-making. The very high temperatures required prevented, however, this process from becoming a practical success.

I have already told you what a complicated series of operations Dr. Pick has lately resorted to in order to obtain the chlorine from this chloride of calcium. Yet the problem of obtaining chlorine as a bye-product of the ammonia soda process presents itself as a very simple one.

This process produces a precipitate of bicarbonate of soda and a solution of chloride of ammonium by treating natural brine, or an artificially made solution of salt, in which a certain amount of ammonia has been dissolved, with carbonic acid. In their original patent of 1838, Messrs. Dyar and Hemming proposed to evaporate this solution of ammonium chloride, and to distil the resulting dry product with lime to recover the ammonia. Now, all that seemed to be necessary to obtain the chlorine from this ammonium chloride was to substitute another oxide for lime in the distillation process, which would liberate the ammonia and form a chloride which, on treatment with atmospheric air would give off its chlorine and reproduce the original oxide. The whole of the reactions for producing carbonate of soda and bleaching powder from salt would thus be reduced to their simplest possible form; the solution of salt, as we obtain it in the form of brine direct from the soil, would be treated with ammonia and carbonic acid to produce bicarbonate and subsequently monocarbonate of soda; the limestone used for producing the carbonic acid would yield the lime required for absorbing the chlorine, and produce bleaching powder instead of being run into the rivers in combination with chlorine in the useless form of chloride of calcium; and both the ammonia (used as an intermediary in the production of soda), and the metallic oxide (used as an intermediary in the production of chlorine), would be continuously recovered.

The realisation of this fascinating problem has occupied me for a great many years. In the laboratory I obtained soon almost theoretical results. A very large number of oxides and even of salts of weak acids were found to decompose ammonium chloride in the desired way; but the best results (as was to be clearly anticipated from thermo-chemical data) were given by oxide of nickel.

When, however, I came to carry this process out on a large

scale, I met with the most formidable difficulties, which it took many years to overcome successfully.

The very fact that ammonium chloride vapour forms so readily metallic chlorides when brought in contact at an elevated temperature with metals or oxides or even silicates, led to the greatest difficulty, viz. that of constructing apparatus which would not be readily destroyed by it.

Amongst the metals we found that platinum and gold were the only ones not attacked at all. Antimony was but little attacked, and nickel resisted very well if not exposed to too high a temperature, so that it could be, and is being, used for such parts of the plant as are not directly exposed to heat. The other parts of the apparatus coming in contact with the ammonium chloride vapour I ultimately succeeded in constructing of cast and wrought iron, lined with fire-bricks or Doulton tiles, the joints between these being made by means of a cement consisting of sulphate of baryta and waterglass.

After means had been devised for preventing the breaking of the joints through the unequal expansion of the iron and the earthenware, the plant so constructed has lasted very well.

Oxide of nickel, which had proved the most suitable material for the process in the laboratory, gave equally good chemical results on the large scale, but occasionally a small quantity of nickel chloride was volatilised through local over-heating, which, however, was sufficient to gradually make up the chlorine conduits. We therefore looked out for an active material free from this objection. Theoretical considerations indicated magnesia as the next best substance, but it was found that the magnesium chloride formed was not anhydrous, but retained a certain amount of the steam formed by the reaction, which gave rise to the formation of a considerable quantity of hydrochloric acid on treatment with hot air. In conjunction with Dr. Eschellman (who carried out the experiments for me), I succeeded in reducing the quantity of this hydrochloric acid to a negligible amount by adding to the magnesia a certain amount of chloride of potassium, which probably has the effect of forming an anhydrous double chloride.

This mixture of magnesia and potassium chloride is, after the addition of a certain quantity of china clay, made into small pills in order to give a free and regular passage throughout their entire mass to the hot air and other gases with which they have to be treated. In order to avoid as far as possible the handling and consequent breaking of these pills, I vapourise the ammonium chloride in a special apparatus, and take the vapours through these pills and subsequently pass hot air through, and then again ammonium chloride vapour, and so on, without the pills changing their place.

The vapourisation of the ammonium chloride is carried out in long cast-iron retorts lined with thin Doulton tiles, and placed almost vertically in a furnace which is kept by producer gas at a very steady and regular temperature. These retorts are kept nearly full with ammonium chloride, so as to have as much active heating surface as possible. From time to time a charge of ammonium chloride is introduced through a hopper at the top of these retorts, which is closed by a nickel plug. The ammonium chloride used is very pure, being crystallised out from its solution as produced in the ammonia soda manufacture by a process patented by Mr. Gustav Jarmay, which consists in lowering the temperature of these solutions considerably below 0° C. by means of refrigerating machinery. The retorts will, therefore, evaporate a very large amount of ammonium chloride before it becomes necessary to take out through a door at their bottom the non-volatile impurities which accumulate in them. The ammonium chloride vapour is taken from these retorts by cast-iron pipes lined with tiles and placed in a brick channel, in which they are kept hot, to prevent the solidification of the vapour, to large upright wrought-iron cylinders which are lined with a considerable thickness of fire-bricks, and are filled with the magnesia pills, which are, from the previous operations, left at a temperature of about 300° C. On its passage through the pills the chlorine in the vapours is completely retained by them, the ammonia and water vapour formed pass on and are taken to a suitable condensing apparatus. The reaction of the ammonium chloride vapour upon magnesia being exo-thermic, the temperature of the pills rises during this operation, and no addition of heat is necessary to complete it. The temperature, however, does not rise sufficiently to satisfactorily complete the second operation, viz. the liberation of the chlorine and the re-conversion of the magnesium chloride into magnesium oxide by means of air. This reaction is slightly endo-thermic, and thus absorbs a small amount of heat, which has to be provided in one way or another. I effect this by heating the pills to a somewhat higher temperature than is required for the action of the air upon them, viz. to 600 C., by passing through them a current of a dry inert gas free from oxygen heated by a Siemens-Cowper stove to the required temperature. I use for this purpose the gas leaving the carbonating plant of the ammonia soda process.

This current of gas also carries out of the apparatus the small amount of ammonia which was left in between the pills. It is washed to absorb this ammonia, and after washing, this same gas is passed again through the Siemens-Cowper stove, and thus constantly circulated through the apparatus, taking up the heat from the stove and transferring it to the pills. When these have attained the required temperature, the hot inert gas is stopped and a current of hot air passed through, which has also been heated to 600° C. in a similar stove. The air acts rapidly upon the magnesium chloride, and leaves the apparatus charged with 18 to 20 per cent. of chlorine and a small amount of hydrochloric acid. The chlorine comes gradually down, and when it has reached about 3 per cent. the temperature of the air entering the apparatus is lowered to 350° C. by the admixture of cold air to the hot air from the stove; and the weak chlorine leaving the apparatus is passed through a second stove, in which its temperature is raised again to 600° C., and passed into another cylinder full of pills which are just ready to receive the hot-air current. A series of four cylinders is required to procure the necessary continuity for the process.

The chlorine gas is washed with a strong solution of chloride of calcium, which completely retains all the hydrochloric acid, and is then absorbed in an apparatus invented by Dr. Carl Langer, by hydrate of lime, which is made to pass by a series of interlocked transporting twin-screws in an opposite direction to the current of gas, and produces very good and strong bleaching powder, in spite of the varying strength of the chlorine gas. The hydrochloric acid absorbed by the solution of calcium chloride can by heating this solution be readily driven out and collected.

This process has now been in operation on a considerable scale at our Works at Winnington for several years, with constantly improving results, notably with regard to the loss of ammonia, which has gradually been reduced to a small amount. The process has fully attained my object, viz. to enable the ammonia soda process to compete, not only in the production of carbonate of soda, but also in the production of bleaching powder, with the Le Blanc process.

Nevertheless, I have hesitated to extend this process as rapidly as I should otherwise have done, because very shortly after I had overcome all its difficulties, entirely different methods from those hitherto employed for the manufacture of chlorine were actively pushed forward in different parts of the globe, for which great advantages were claimed, but the real importance and capabilities of which were and are up to this date very difficult to judge. I refer to the processes for producing chlorine by electrolysis.

During the first decade of this century, Humphry Davy had by innumerable experiments established all the leading facts concerning the decomposing action of an electric current upon chemical compounds. Amongst these he was the first to discover that solutions of alkaline chlorides, when submitted to the action of a current, yield chlorine. His successor at the Royal Institution, Michael Faraday, worked out and proved the fundamental law of electrolysis, known to everybody as "Faraday's Law," which has enabled us to calculate exactly the amount of current required to produce by electrolysis any definite quantity of chlorine. Naturally, since these two eminent men had so clearly shown the way, numerous inventors have endeavoured to work out processes based on these principles for the production of chlorine on a manufacturing scale, but only during the last few years have these met with any measure of success.

It has taken all this time for the classical work of Faraday on electro-magnetism to develop into the modern magneto-electric machine, capable of producing electricity in sufficient quantity to make it available for chemical operations on a large scale; for you must keep in mind that an electric installation sufficient to light a large town will only produce a very moderate quantity of chemicals.

In applying electricity to the production of chlorine, various ways have been followed, both as to the raw materials and as to the apparatus employed. While most inventors have proposed

to electrolyse a solution of chloride of sodium, and to produce thereby chlorine and caustic soda, I am not aware that up to this day any quantity of caustic soda made by electrolysis has been put on to the market.

Only two electrolytic works producing chlorine on a really large scale are in operation to-day. Both electrolyse chloride of potassium, producing as a bye-product caustic potash, which is of very much higher value than caustic soda, and of which a larger quantity is obtained for the same amount of current expended. These works are situated in the neighbourhood of Stassfurt, the important centre of the chloride of potassium manufacture. The details of the plant they employ are kept secret, but it is known that they use cells with porous diaphragms of special construction, for which great durability is claimed. There are at this moment a considerable number of smaller works in existence, or in course of erection in various countries, intended to carry into practice the production of chlorine by electrolysis by numerous methods, differing mainly in the details of the cells to be used; but some of them also involving what may be called new principles. The most interesting of these are the processes in which mercury is used alternately as kathode and anode, and salt as electrolyte. They aim at obtaining in the first instance chlorine and an amalgam of sodium, and subsequently converting the latter into caustic soda by contact with water, which certainly has the advantage of producing a very pure solution of caustic soda. Mr. Hamilton Castner has carried out this idea most successfully by a very beautiful decomposing cell, which is divided into various compartments, and so arranged that by slightly rocking the cell the mercury charged with sodium in one compartment passes into another, where it gives up the sodium to water, and then returns to the first compartment, to be recharged with sodium. His process has been at work on a small scale for some time at Oldbury near Birmingham, and works for carrying it out on a large scale are now being erected on the banks of the Mersey, and also in Germany and America.

Entirely different from the foregoing, but still belonging to our subject, are methods which propose to electrolyse the chlorides of heavy metals (zinc, lead, copper, &c.) obtained in metallurgical operations or specially prepared for the purpose, among which the processes of Dr. Carl Hoepfner deserve special attention. They eliminate from the electrolyte immediately both the products of electrolysis, chlorine on one side and zinc and copper on the other, and thus avoid all secondary reactions, which have been the great difficulty in the electrolysis of alkaline chlorides.

All these processes have, however, still to stand the test of time before a final opinion can be arrived at as to the effect they will have upon the manufacture of chlorine, the history of which we have been following, and this must be my excuse for not going into further details. I have endeavoured to give you a brief history of the past of the manufacture of chlorine, but I will to-day not attempt to deal with its future! Yet I cannot leave my subject without stating the remarkable fact that every one of these processes which I have described to you is still at work to this day, even those of Scheele and Berthollet, all finding a sphere of usefulness under the widely varying conditions under which the manufacture of chlorine is carried on in different parts of the world.

Let me express a hope that a hundred years hence the same will be said of the processes now emerging and the processes still to spring out of the inventor's mind. Rapid and varied as has been the development of this manufacture, I cannot suppose that its progress is near its end, and that nature has revealed to us all her secrets as to how to procure chlorine with the least expenditure of trouble and energy. I do not believe that industrial chemistry will in future be diverted from this Section and have to wander to Section A under the ægis of applied electricity. I do not believe that the easiest way of effecting chemical changes will ultimately be found in transforming heat and chemical affinity into electricity, tearing up chemical compounds by this powerful medium, and then to recombine their constituents in such form as we may require them. I am sure there is plenty of scope for the manufacturing chemist to solve the problems before him by purely chemical means, of some of which we may as little dream to-day as a few years ago it could have been imagined that nickel would be extracted from its ores by means of carbon-monoxide.

At a meeting of this Association which brings before us an entirely new form of energy, the Röntgen rays, which have enabled us to see through doors and walls and to look inside the human body; which brings before us a new form of matter, represented by Argon and Helium, which, as their discoverers, Lord Rayleigh and Prof. Ramsay, have now abundantly proved, are certainly elementary bodies, inasmuch as they cannot be split up further, but are not chemical elements, as they possess no chemical affinity and do not enter into combinations—at a meeting at which such astounding and unexpected secrets of nature are revealed to us, who would call in doubt that, notwithstanding the immense progress pure and applied science have made during this century, new and greater and farther-reaching discoveries are still in store for ages to come?

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE action of the nominating Committee of the American Association (see NATURE of September 10), in recommending a merely formal meeting next year at Toronto, on the day preceding that of the British Association, evoked a storm of opposition in the general session, and a vote was passed requiring the Council to arrange for a regular meeting and fix the time and place.

The Council subsequently fixed on August 9, 1897, as the time, and Detroit as the place, providing for a recess to Toronto before the final adjournment, in order to welcome the British Association.

Of the various Sections, popular interest evidently centred in that of Social and Economic Science, as was evinced by the very large attendance, and by the attention devoted to its proceedings by the daily press of Buffalo. The first paper read before this section, on "The Monetary Standard," taking strong ground for the gold standard, was read by Wm. H. Hale. Edward Atkinson sent a paper entitled "What is True Money?"; also one entitled "Crime against Labour." Other papers were: "The Competition of the Sexes and its Results," by Lawrence Irwell; "Fashion—a Study," by S. E. Warren; "Citizenship, its Privileges and Duties," "Relics of Ancient Barbarism," and "Practical Studies in Horticulture, Art and Music," by S. F. Kneeland; "An Inheritance for the Waifs," by C. F. Taylor; "The Proposed Sociological Institution," by James A. Skilton; "The Value of Social Settlement," and "The Wages Fund Theory," by A. B. Keeler; "Better Distribution of Forecasts," by John A. Miller; "The Tin-plate Experiment," by A. P. Winston, and "Suicide Legislation," by W. L. O'Neill.

Thirty-five papers were read in the Anthropological Section, including contributions from Brinton, Boas, McGee, Fletcher, Beauchamp, Wright, Mercer, and others. Especial interest was felt in the paper of Secretary F. W. Putnam, on the researches made in the ancient city of Coapan, located in Honduras, just over the border from Guatemala.

Prof. Putnam was the first to go beneath the surface. He began in Yucatan, and soon found that buildings now on the surface were of recent date; but underneath were indications of remote antiquity. City has been built over city, in one place as many as five having been superposed, showing as many successive occupations.

The two Biological Sections had twenty-three papers in zoology and forty-two in botany. Among the well known contributors were L. O. Howard, E. D. Cope, L. M. Underwood, T. N. Gill, D. S. Kellicott, C. E. Bessey, J. M. Coulton, and N. L. Britton, The Botanical Club also held several meetings, and the botanists devoted all day Friday to an excursion by lake to Point Abino.

The Geological Section was enriched by all the papers from the Geological Society of America, which held merely a business meeting, an arrangement now adopted for the first time, but so successfully that it will be extended next year to the Chemical Society, and ultimately to other affiliated societies. Thirty-four papers were read to the geologists, among prominent contributors being B. K. Emerson, Warren Upham, I. C. White, E. W. Claypole, G. K. Gilbert, and J. W. Spencer. H. O. Hovey, who has made a speciality of cave explorations, gave interesting accounts of new discoveries in Mammoth Cave and elsewhere. The feature of this Section was the commemorative exercises on Wednesday afternoon, referring to the sixtieth anniversary of the work of Prof. James Hall in connection with the survey of New York State. Addresses and papers were given by Prof. Emerson, Prof. Joseph Le Conte, W. J. McGee,

John M. Clarke, and others. Three of those present at that gathering had attended the meeting of the American Association for the Advancement of Science at Albany in 1856, at which Prof. Hall presided, and which was the largest scientific gathering up to that time held in America. They were Joseph Le Conte, Thomas H. Feary, and Wm. H. Hale.

The proximity of Niagara, and the new applications of power, gave special interest to the Section of Mechanical Science and Engineering, and twenty-two papers were read. Henry T. Eddy, Thomas Gray, J. E. Denton, D. S. Jacobus, and Octave Chanute were among the contributors. A most important paper was read by Elmer L. Corthell, entitled "Some Notes, Physical and Commercial, upon the Delta of the Mississippi River." Mr. Corthell has made a special study of the Mississippi for many years. He points out certain measures where he pronounces necessary to preserve navigation of the delta. The United States has already expended thirty-eight million dollars in the improvement of the Mississippi.

The Chemical Section was crowded with papers, about seventy being read. Among the contributors were A. A. Noyes, A. B. Prescott, H. W. Wiley, R. B. Warder, F. W. Clarke, T. H. Norton, C. B. Dudley, W. P. Mason, J. L. Howe, C. F. Mabery, H. A. Weber, E. W. Hilyard, A R. Leeds, Wm. McMurtrie, L. L. Van Slyke, and E. A. de Schweinitz. The papers were mostly technical, and were arranged in groups according to the subjects. The programme of the American Chemical Society, which met in the preceding week, was also a long one, indicating an unusual interest in chemistry. At the meeting Prof. Dennis stated that he had found potassium platinocyanide, $K_2Pt(CN)_4$, by far the best material for painting fluorescent screens for X-ray investigation.

Physics also aroused much interest, and it was remarked that the Section had never had a better programme. Of the thirty-two papers presented, Wm. A. Rogers read five. In one of these he maintained that X-ray pictures could be obtained by the use of static electricity, and he exhibited several pictures taken in that manner. Among others, papers were read by Ernest Merritt, Edward L. Nichols, and Alexander Macfarlane.

The Section of Mathematics and Astronomy was the lightest of all, having only ten papers and no presidential address, Mr. Wm. E. Story being absent in consequence of sickness in his family. Alexander Macfarlane was elected vice-president in his place. G. W. Hough contributed a paper on motion of the great red spot and equatorial belt of the planet Jupiter from 1879 to 1896, and L. A. Bauer one on component fields of the earth's magnetism.

The evening addresses before the Association were by J. W. Spencer, on "Niagara as a time-piece," and by E. D. Cope, on "The results of cave explorations in the United States, and their bearing on the antiquity of man." Spencer's last estimate of the age of Niagara is 31,500 years. In about 5000 years he predicts that the elevation of the north-east will suffice to turn the drainage of the great lakes into the Mississippi River. Prof. Cope gave an exhaustive review of cave explorations.

Contributions to the monument to Pasteur were solicited from the Association, but funds were not available, except from Mrs. Esther Herrman, a patron of the Association, who contributed 100 dollars for that purpose. Grants for research were only made to the extent of 200 dollars, for the same reason ; and were allocated as follows :—To the Marine Biological Laboratory, Woods Holl, Mass., for a table (appointment to be made by the vice-presidents for Sections F and G and the director of the laboratory), 100 dollars; to Francis E. Phillips, for investigations on the properties of natural gas, 50 dollars ; to L. A. Bauer for investigations on terrestrial magnetism in connection with the magnetic survey of Maryland, 50 dollars.

The President and Vice-Presidents of the next meeting are :— President, Wolcott Gibbs. Vice-Presidents : (A) Mathematics and Astronomy, W. W. Beman ; (B) Physics, Carl Barus ; (C) Chemistry, W. P. Mason ; (D) Mechanical Science and Engineering, John Galbraith ; (E) Geology and Geography, I. C. White ; (F) Zoology, G. Brown Goode ; (G) Botany, George F. Atkinson ; (H) Anthropology, W. J. McGee ; (I) Social and Economic Science, Richard T. Colburn.

An unusually large number of Fellows were elected, among whom must be mentioned Wolcott Gibbs, he having been elected honorary fellow in order to qualify for the presidency of the Association, of which he had not been a member for nearly thirty years.

The matter of the approaching jubilee (in 1898) of the Association was discussed, but no definite decision was arrived at. As the probable place of meeting that year, Secretary Putnam suggested Boston, a city already memorable in the annals of the Association as the place where the largest meeting of members—not counting foreign guests—was held.

THE RECENT CYCLONE IN PARIS.

THERE seems to be very little doubt that Paris on Thursday last was visited by a tornado, the first time within the memory of man. It was accompanied by that mysterious circular motion that is special to this class of storm, and extended over a very small area, beginning at the Place St. Sulpice and ending at the Boulevard de la Villette, a distance of nearly two miles. It, however, caused considerable damage, resulting in, it is said, seven deaths and many severe injuries. On the day in question there had been since noon a succession of showers, and it was towards the last of these—about 3 p.m.—that the tornado showed itself. M. Angot, head of the Meteorological Bureau, was at the Pont Royal, about to take a boat, when he noticed small dark clouds, very low down, apparently moving against the wind, which was not at all high, the velocity not being more than five or six yards a second. He soon, however, perceived that the clouds had a rapid circular motion, not horizontal, but oblique. When making these observations he judged the distance of the storm to be about a mile, and its diameter about 170 yards. At the Tour St. Jacques, the meteorologist there states that the storm lasted less than a minute. Some black clouds passed swiftly overhead, and there was one flash of lightning. The barometer suddenly fell from 748 mm. to 742 mm., a drop of 6 mm. ; a fact unprecedented for years, but almost immediately afterwards rose again. Advancing from this point towards the north-east, branches and, in some cases, whole trees fell on the roadways, and boats on the river were torn from their moorings and dashed on the quays. Omnibuses were upset, cabs thrown about, and stalls overturned. So strong was the force of the wind that the Palais de Justice had its windows broken and was partly unroofed. The roofs of the Opéra Comique, the Châtelet, the Tribunal of Commerce, and the Préfecture of Police were considerably damaged, and in some cases partly removed. Owing to the great damage done to the numerous windows of every house, the streets were strewn with enormous quantities of glass broken into small pieces. Some curious instances are related. A kiosk in front of the Ambigu, in which were seated two policemen, was carried, together with the policemen, to the other side of the street ; the kiosk was completely wrecked, but the policemen were unhurt though shaken. The heavy rain which continued during the storm did considerable damage, filling up cellars, &c., and flooding the river Bièvre. It was owing, perhaps, to this rain, which had cleared the streets of people, that the number of accidents was not greater than was recorded.

We have received the following further details from a correspondent in Paris :—

"The storm which we experienced took meteorologists quite by surprise, and it was found impossible to follow the track of the cyclone out of Paris. It appears that it developed at the Place St. Sulpice, and disappeared at La Villette, seven kilometres in the north-north-east direction.

"The path of destruction was limited to about one hundred yards, but omnibuses were overturned, boats on the Seine wrecked, five persons killed, seventy wounded, and about 100 trees uprooted. One of the most extraordinary places of devastation was the Square de la Tour Saint Jacques, where the Central Municipal Observatory is established. The branches of trees accumulated by the wind were so numerous that I was obliged to use ladders for visiting the observers, who were practically prisoners in the observatory. Most interesting observations were taken from the top of the Eiffel Tower ; these will be discussed in the forthcoming International Congress of Meteorology."

In a later communication our correspondent says :—

"A singular observation was registered on the barometer at 2h. 40m. p.m. on the 10th, when the storm raged in Paris. A rise of 1 mm. of mercury was registered, but of such a short duration that it was hardly possible to detect the two separate strokes for the greater part of the variation. (It may here be

stated that the instrument was a self-recording one, the mode of registration being graphical.) A similar aërial commotion was registered at the Tour St. Jacques; but, instead of marking an increase of pressure, the trace showed a depression of 6 mm., and of very short duration."

PREHISTORIC EUROPEAN ART.

IT is important to determine how far culture can independently arise in a given district, and how far it is dependent upon other centres of civilisation. For many years M. Salomon Reinach has devoted himself to these problems, especially in reference to the culture of prehistoric Europe. In his essays on "Le Mirage Orientale" he opposed the very prevalent idea that all our culture necessarily came from the East, and during the last three years he has contributed to *L'Anthropologie* a series of articles on "Sculpture in Europe before the Greco-Roman Influences." This long series of papers is concluded in the current number (No. 2, vol. vii.) of that journal, and it forms a mine of information which cannot but prove of immense value to archæological students, especially as it is illustrated with 441 outline sketches culled from a vast array of authors. His general thesis comprises two arguments—the one negative, the other positive.

(1) M. Reinach tries to prove that the most primitive European artistic remains are far from justifying the view that the first models and tentative efforts came from Egypt or Babylon. One cannot trace any imitation of Assyrian cylinders or of Egyptian funereal figurines. The fauna figured by the rude artists of Europe is purely European; there is no lion, panther, or camel. An apparently very grave difficulty occurs in the series of figures representing nude females, which authors agree in regarding as imitations of the Babylonian Astarte. M. Reinach argues that this type was indigenous, and so far from owing its existence to Babylonian influence, it, on the contrary, worked its way, in all probability, towards the valleys of the Euphrates and Tigris. He thinks that Europe (*i.e.* the Balkan Peninsula, the Archipelago, the Caucasus, and the west coast of Asia Minor) only later, and to a restricted degree, became dependent upon the old civilisations of the Orient. In his opinion culture is polygamist. He admits multiple centres of creation for art, and refuses to believe that all illumination has come to us from the Euphrates and the Nile. He thinks that the Danube and the Rhine have some rights which should not be neglected, and that the future barbarians who dwelt along the borders of these rivers were not reduced to receive everything from without.

(2) M. Reinach recognises that it is not sufficient to affirm that art can be born in diverse places, and that the germ has not arisen from two or three privileged centres of the ancient world; and so he sets himself to show how the rudiment of art has been able to arise, even among peoples whose genius was for a long time in abeyance. To that purpose M. Reinach has "insisted on the evolution of the most simple decorative motives which, at a certain point, quite naturally suggested the idea of the human or animal form. In these not very numerous cases one can follow the transformations of a plastic motive down to the entirely geometric figure from which it arose. But the taste for geometric forms and the tendency to conventionalisation (*stylisation*), that is to say, to the purely decorative modification of organic lines, have been, for long centuries, so powerful in Europe, that even foreign types have not escaped their petrifying action. *A fortiori*, the indigenous types, arisen from geometrical devices, have always been constrained to return back to them again. It is not denied that in Europe, as elsewhere, the imitation of surrounding nature has given origin to some plastic attempts; but there is proof that this inspiration drawn from nature has been feeble, even in the imitation of animal forms, which represented only a very small number of the animals known to the people."

The author admits that several statuettes figured in this memoir reflect outside influences, particularly of Italy, where Ionian art early took root. But these influences were not exercised in an immediate manner, and the indigenous style appears to have always been predominant even when brought face to face with foreign objects. A similar phenomenon is noticeable in Italy itself, which was Hellenised very slowly, and was only partially Orientalised under the Roman empire.

Such is an outline of M. Reinach's position. There is no doubt that it will open up a wide discussion, as he covers a great deal of ground, and deals with some matters which admit of diversity of opinion.

M. Reinach, in an earlier section of his memoir (*L'Anth.* v., 1894, p. 305), definitely states that "in the primitive art of Central Europe the geometric form (a triangle) has suggested the anthropomorphic form, and it is not the anthropomorphic figure which is degenerated into the geometric." Possibly some, at all events, of these flat plates had indications of features painted on their surface, and thus they may have been more realistic than now appears, and later they were made more human-like as the fabricators became more skilled, or as they valued greater realism.

The investigations of quite a number of men of science show that so-called "geometric" designs are often really highly conventionalised representations of natural objects, mainly of animals; others are suggestions of textiles, or other handicrafts. Probably relatively few "geometric" designs are purely meaningless decorations. So far as available evidence goes, there are not many (if any) examples of the evolution of human or animal forms by "suggestion" from purely geometric designs, but the reverse process is extremely common. Doubtless some of the problems involved in this memoir will be fully discussed at the forthcoming meeting of the British Association at Liverpool during the great discussion, which has been arranged for on the culture and origins of the Mediterranean race. We understand that M. Reinach intends to be present on this occasion, when he will be able to state his views and reply to his critics.

NOTES.

THE seventh annual general meeting of the Federated Institution of Mining Engineers began, with a good attendance, at Cardiff on Tuesday last, under the presidency of Mr. G. A. Mitchell. The report of the Council showed satisfactory progress. It was announced that Mr. Lindsay Wood has been elected President of the Institution.

THE third annual congress of Sunday Societies is announced to take place at Newcastle-on-Tyne, on October 10 and two following days. Copies of the programme of proceedings may be had of the Honorary Secretary, Mr. Mark H. Judge, 7 Pall Mall, S.W.

A REUTER dispatch from Naples says the death is announced of Senator Palmieri, Director of the Vesuvius Observatory. Luigi Palmieri was born in 1807. He was successively Professor of Mathematics at Salerno, Campobasso, and Avellino, Professor of Physics at the Royal Naval School at Naples, and Professor at the University in the same town. In 1854 he was appointed Director of the Vesuvius Meteorological Observatory. He was inventor of several instruments for the observation of natural phenomena, including an electrometer for ascertaining the amount of electricity in the atmosphere, a rain gauge, and a seismometer.

PROF. J. C. BOSE, of the Presidency College, Calcutta, is at present in this country, having been deputed by the Indian Government to visit the various laboratories in Great Britain and on the continent, with a view to the extension of the Calcutta Presidency College Laboratory, and the establishment of a new magnetic observatory in connection with that College. Prof. Bose is the holder of a Royal Society grant for researches in regard to electricity. He is a D.Sc. of London University.

IT was announced at a banquet given to Dr. Nansen at Christiania, on Thursday last, that a Nansen fund had been formed for the advancement of science. Subscriptions to the amount of 210,000 kroners had already been received.

THE Russian Geographical Society has been asked by the Governor-General of Turkestan to send some men of science to Shignan and Roshan next summer, for the purpose of making a thorough exploration of those regions.

M. MOUREAUX, who has just returned from Russia, has made observations of some quite surprising magnetical perturbations. On August 29, special perturbations were observed by him of the same kind that are generally registered when connected with earthquakes. He remained several days supposing that he had been mistaken, when he learned through a steamer which arrived that Hecla had been in eruption on that same night. The exact times of occurrence of these perturbations were 11h. 36m., 11h. 42m., 11h. 46m. p.m. Paris mean time.

PROF. H. MOHN informs us that Captain Salvesen, Royal Norwegian Navy, commanding the sloop-of-war *Ellida*, on July 28, when off the promontory of Stat, on the west coast of Norway, saw the "blue sun" at sunset. The phenomenon was seen twice, the ship being lifted on the waves, with an interval of a few seconds of time. The sun was quite clear at setting. It is curious that this beautiful sight is so rarely looked for.

IT is reported that the War Department of the United States has sent to Paris for a set of the Bertillon instruments, and that a thorough examination into the system of identification is to be made with a view to its introduction into the United States Army.

THE *Evening Post* of New York learns that Prof. C. W. Dodge, of the Biological Department of the University of Rochester, has asked the trustees to make an appropriation for the establishment of a biological laboratory at Hemlock Lake, a small lake thirty miles south of Rochester, from which the city obtains its water-supply. Prof. Dodge proposes to make, with the assistance of students from his department, a complete biological survey of the lake.

PROF. A. HALL, JUN., Director of the University of Michigan Observatory, according to *Popular Astronomy*, has secured an extensive series of observations of Polaris for latitude variation. He is also engaged on the division errors of the meridian circle, no examination of the errors having been made for some considerable time.

MR. E. H. PARKER, who has been for the past fifteen years in the experimental department of Messrs. Wm. Denny and Bros., Leven Ship-yards, has been appointed Secretary to the Institution of Engineers and Shipbuilders in Scotland, in the place of Mr. W. D. Millar, who is retiring after twenty-five years' service.

WE have received from Colonel A. T. Fraser, R.E. (retired list), two radiographs, one of a European, and the other of a Hindu hand, taken by means of Röntgen rays under precisely similar conditions. Colonel Fraser is of opinion that the evident difference in appearance suggests that the skin pigment of the hand of the Hindu intercepts the rays.

THE Society of Medical Phonographers, to which we have referred on former occasions, has made steady progress during the past year, and now has 250 names on its books. The Society issues a monthly medical periodical, entitled the *Record*, in lithographed shorthand; in addition to this publication it has brought out two small pamphlets dealing with the use of shorthand by the student and by the practitioner respectively, and has issued a list of more than 2500 phonographic outlines of medical terms. The Society intends, at the end of October or the beginning of November, to hold an examination in shorthand for students of medicine commencing their first winter session. Prizes will be given for proficiency in the art.

A LIST of free popular lectures to be delivered in the Chemical Theatre of Owens College, Manchester, on Saturday afternoons during the session, has been sent us. On October 24 will be begun the first of three discourses on "The Geological History of the District round Manchester," by Prof. Boyd Dawkins, and on subsequent dates the following lectures will be given:—"The Inhabitants of the Seas," by Prof. Hickson; "Economic Botany," by Prof. Weiss; "Soils, their Nature and Origin," by Dr. Burghardt; "Birds," by Mr. Hoyle. In addition to these lectures, others of a popular character will be delivered on Monday evenings during the session. In the list we notice one by the Archdeacon of Manchester, on "Falling Stars as a Branch of Astronomy"; one on "The Electric Furnace," by Prof. Roberts-Austen; and two, by Prof. H. B. Dixon, on "The Nature of Flame."

THE *Pioneer Mail* (Allahabad) of August 19 contains an account of the proceedings at the last meeting of the Central Committee of the Pasteur Institute of India. At this meeting it was unanimously decided "that the scope of the Institute as embodied in the extended scheme laid before the meeting be accepted and published." The scheme in question is as follows: I. The practical application of bacteriological methods to the prevention and cure of disease, viz.: (*a*) Inoculations against rabies. (*b*) Preparation and preservation of cholera vaccines for distribution when necessary, and the carrying out of anti-cholera inoculations. (*c*) Preparation of diphtheria anti-toxin. (*d*) Preparation of anthrax vaccine. (*e*) Preparation of tuberculin (for diagnostic purposes). (*f*) Preparation of mallein (for diagnostic purposes). (*g*) Vaccination against tetanus. II. The investigation of tropical diseases especially prevalent in India; that is to say: (*a*) Research intended to generalise methods already in use, and to test the actual value of proposed methods, namely: (1) Vaccination against enteric fever. (2) The use of *anti-venene* in snake-bit. (3) The curative treatment of cholera. (*b*) The investigation of the following diseases: malaria, kala azar, dysentery, abscess of the liver, beri beri, &c. (*c*) Fermentations, including indigo, opium, tea. III. The provision of a centre which would afford to medical officers, already trained in bacteriological technique, the means for the prosecution of independent research, and for the acquisition of advanced knowledge of bacteriological methods of dealing with disease, under the guidance and supervision of the officers of the Institute. The selection of the site for the Institute has yet to be made.

WE are glad to hear that the Crystal Palace Company are about to arrange for a series of entertainments and lectures during the ensuing autumn and winter months, to be given every Wednesday evening. The lectures will be devoted to the exemplification of the various great discoveries and inventions of the Victorian era, and will be delivered by eminent men of science. We wish the Crystal Palace every success in this venture, and hope that the Company's example may be followed by others. The last half-century, perhaps, holds the record for the greatest advancement in science during a period of this length, so that the lectures will have a broad basis from which to draw their material.

VERY little doubt now exists as to the value of a captive balloon for reconnoitring purposes; and its importance has been lately displayed during the recent manœuvres. The military correspondent of the *Pall Mall Gazette* gives an interesting account of this special detachment; it consists of three officers and a dozen sappers. The balloon can lift $2\frac{1}{2}$ cwt. The apparatus consists of a cart drawn by four horses, with two drums or winches, and round them is the hawser of twisted strands of wire which anchors the balloon. The balloon is generally allowed to ascend 1000 feet, and this is done by unwinding the wire. Messages are sent down in small bags fixed loosely on the hawser, and the officer at the bottom is either connected by wire with the General's headquarters, or has mounted orderlies at his disposal. A simple and rapid

means is adopted for bringing the balloon to earth. A stout pole, 10 feet long, is laid on the wire, and a couple of sappers take hold of each side, and double along, pressing on the pole all the time. The balloon is then made to come to earth in about two minutes; of course, some distance from the waggon. To let it up again, they double back, keeping the pole of the waggon horizontal; this system naturally saves much time and winding. To move the balloon from place to place, it is pulled down until it is on the top of the waggon, where it is held while the waggon is being driven along. The value of a balloon, the correspondent says, can hardly be over-estimated, both for reconnoitring the enemy and also as a means of keeping a General informed of the positions reached by his own troops. Sketches showing accurately all the enemy's dispositions can be thus easily obtained, which would otherwise have to be done by mounted troops, and, perhaps, not so thoroughly.

Considerable danger appears to attend the consumption of the popular Norwegian cheese known as "Pult-ost" or "Knad-ost," in consequence of the vigorous kneading which it undergoes in process of manufacture. Several authentic instances of severe attacks of intestinal catarrh having followed the eating of this particular variety of cheese, attention has at last been directed to the subject, and an elaborate investigation has lately been carried out by Dr. Axel Holst. of Christiania. The bacteriology of the cheese in question has been specially studied, and elaborate examinations were made of those cheeses to which the above epidemic was attributed. The results obtained are of considerable interest; for not only has Dr. Holst isolated out the responsible microbe, but he has identified it as being a virulent variety of the *B. coli communis*. Thus fresh evidence is to hand in support of the now frequently expressed view that this microbe, so extensively present in our surroundings, and normally present in the animal system as a harmlesss saprophyte, may by some process, at present unknown to us, become endowed with highly toxic properties. Dr. Holst suggests that the original infection of the milk may have been brought about by want of cleanliness in milking, coupled with an unhealthy condition of the cow itself—circumstances which have already been proved to have induced diarrhœa in the case of persons who consumed such contaminated milk.

Dr. C. Hart Merriam, of the U.S. Department of Agriculture, has prepared a synopsis of the weasels of North America, which has just been issued from the Government printing office. Dr. Merriam recognises one ferret and twenty-two weasels, as being at present known in North America, and refers the former to the sub-genus *Putorius*, and the latter to the sub-genus *Ictis* of the same genus. Eleven species of North American weasels are now described as new for the first time. Five plates are added to this excellent memoir to illustrate the skulls and dentition of the various species.

From a memoir lately presented to the Imperial Academy of Sciences of St. Petersburg by Herr Eug. Büchner, it would appear that the European bison, in spite of the stringent efforts made by the Czars since the beginning of the present century for its protection, is likely to share the fate of its American relative, and to become extinct as a wild animal. The celebrated herd of the forest of Bjelowjesha, in Lithuania, which in 1856 was nearly 1900 in number, has of late years become reduced to under 500, and shows no signs of increase. The chief cause of this failing is attributed, by Herr Büchner, to "breeding in," in consequence of the confined area to which these huge animals are now restricted. Another reason is, no doubt, the fact that the male bisons considerably exceed the females in number. We venture to suggest that it would be wise to remove a large number of bisons of the male sex from the forest, and, if possible, to introduce a change of blood from the second herd of the same animal which still exists on the northern slopes of the Caucasus.

A very interesting feature of primary education in Russia is the establishment and rapid development of small farms, orchards, and kitchen-gardens in connection with many primary schools, especially in the villages. The land for such model gardens, or farms on a small scale, was mostly obtained through free grants from the village communes and, occasionally, from the neighbouring landlords; while the expenses are covered by very small money grants from the country and district Councils (*zemstvos*). To take one province in South Russia, namely Ekaterinoslav, we see from the biennial report, just issued, that not only has almost every school an orchard and kitchen-garden for the use of the schoolmaster, but that nearly one-half of the schools in the province (227 out of 504) are already in possession of small model kitchen-gardens, orchards, tree-plantations, or farms, at which gardening, sylviculture, and sericulture are regularly taught. The teaching is mostly given by the schoolmasters, who themselves receive instruction in these respective branches at courses voluntarily attended in the summer, or occasionally by some practical specialist of the neighbourhood. The province of Ekaterinoslav being mostly treeless, special attention is given to tree plantations and, next, to silkworm culture. The aggregate area of the 227 school-farms or gardens attains 283 acres, and they contained, in 1895, 111,000 fruit trees and 238,300 planted forest trees; nearly 14,000 of the former and 42,000 of the latter having been distributed free among the pupils during the same year. The money grants for these 227 gardens were very small—*i.e.* a little over three hundred pounds (£314). Besides, over a thousand beehives are kept, partly by the schoolmasters and partly by the children; and some schools had vineyards in connection with them. This movement has widely spread over different provinces of Central Russia, where the culture of cereals dominates at the school farms; while in Caucasia attention is especially given to the silkworm culture and the culture of the vine.

The following particulars of munificent gifts and bequests to libraries of America are gathered from *Science*:—The New York Free Library, from members of the Astor family, about £330,000; from James Lennox, £147,000, in addition to books and land; from the Tilden estate, £400,000; the John Crerar Library, of Chicago, from the founder, about £540,000; the Newberry Library, of Chicago, from the founder, about £500,000; the Carnegie Library, of Pittsburg, from the founder, £420,000; the Enoch Pratt Free Library, of Baltimore, from the founder, about £216,000; the Library Company, of Philadelphia, from the founder, Dr. Rush, about £212,000; the Library of Columbia University, from President Low, £200,000.

The first article in the September part of the *Geological Magazine* is devoted to an historical account of the Palæontographical Society of London, the jubilee of which was celebrated on June 19 last. The origin of the Society was mainly due to the prior issue of Sowerby's "Mineral Conchology," of which the first part appeared in June 1812, and was followed by other parts for over thirty years. The portions of this work were brought out slowly and irregularly, and rarely illustrated more than ten species at one time, and it was thought that as the "Mineral Conchology," at its then rate of issue, could not possibly depict all the British fossils within a moderate period, it would be well to have recourse to another method. The outcome of the suggestion made was the calling together of a meeting on March 23, 1847, at the apartments of the Geological Society, with Sir Henry De la Beche in the chair, when it was resolved that a Society be constituted, the object of which should be "to figure and describe as completely as possible a stratigraphical series of British fossils." The meeting

further determined that the annual subscription should be one guinea, that the name of the Society should be the Palæontographical, and that its officers should consist of a president, treasurer, secretary, and council of sixteen members. Sir Henry De la Beche was elected first president. The presidents from the foundation to the present have been: Sir H. De la Beche, from 1847 to 1855; Mr. W. J. Hamilton, from 1856 to 1867; Dr. Bowerbank, from 1868 to 1876; Sir R. Owen, from 1877 to 1892; Prof. Huxley, from 1893 to 1895; and since then Dr. Henry Woodward. Want of space will not permit of our giving a list of the monographs issued by the Society; suffice it to say that they range over a large area of information comprehending the fossil Plantæ, &c., fossils from the sub-kingdoms Protozoa, Porifera, Cœlenterata, Echinodermata, Annulosa, Mollusca, and Vertebrata; and that monographs are in progress on the Foraminifera of the Crag, the Fossil Sponges, the Cretaceous Star-Fishes, the Carboniferous Mollusca, the Inferior Oolite Ammonites, the Fishes of the Old Red Sandstone, the Pleistocene Mammalia, and the Devonian Fauna. The Honorary Secretary of the Society, Prof. Wiltshire, will, we are sure, be glad to receive the names and subscriptions of many new members.

IT may be remembered that some time ago the Austrian man-of-war *Pola* returned from her voyage of investigation in the Red Sea, after having spent eight months there, and surveyed the northern half of this region, covering an area of about 600 nautical miles long by 180 broad. An account of the work accomplished during this trip is given in *Die Natur* (No. 37), and seems to be of great importance. No less than seventy boxes, containing fish and smaller Seetiere, and twelve large boxes full of coral have already been despatched to Vienna. Other results of observation tell us that at a depth of 500 metres the water commences to become homogeneously warm, having a temperature to the bottom of 21°·2. The amount of salt at the time of observation was greatest in the northern part, diminishing towards the south; the transparency of the water was found to be less than that of the Mediterranean Sea; and the colour was not so fine and of such a distinct blue as is the case of the Mediterranean and Adriatic Seas. Altogether 1243 temperature observations, 691 determinations of the specific gravity at the surface, half-way down, and at the bottom, 254 colour observations, and 22 determinations of wave-elements were made. The investigation included further innumerable chemical analyses of the water from the deeper parts, and observations of the chemical changes taking place between the Red Sea and the land surfaces. At most of the harbours and places of anchorage the officers made astronomical position and time determinations, magnetic observations for all three elements—declination, inclination, and intensity, and pendulum observations for the determination of the force of gravity. The above were made at twenty-seven stations on land and islands, twelve being on the Egyptian coast, ten on the Arabian, and the rest on the half-island Sinai. Meteorological observations were also strictly made, thus completing a valuable amount of work in an important region.

THE current number of *La Nature* (September 12) has some specially interesting articles. M. de Navaillac gives us an account of some of the prehistoric finds that have been made in Florida, referring to the work done especially by Mr. Frank Cushing, who was sent out by the University of Pennsylvania. His researches seem to have been very successful, and he was rewarded with sufficient material to permit him to describe the life and costumes of the race that had peopled the land. Dr. Felix Regnault discourses on the origin of ornamental art: the principles which actually guide ornamental art date neither from the Renaissance, nor even from the Greek period. They result "d'une tendance naturelle à l'homme telle qu'on retrouve dans les origines mêmes de l'humanité." "Renaissance Clocks" is the subject of an article by M. Planchon, who describes some of these beautiful works of art. There are several illustrations showing the different methods of design adopted.

THE *Bulletin de la Société d'Encouragement pour l'industrie Nationale* for the month of August contains various articles which should be read with interest. M. Ronna, in a long summary of sixty-four pages, gives an account of the dry regions in the United States of America, and describes at some length the different methods of irrigation employed to suit the various local conditions. Plans, cross-sections and photogravures are given to illustrate the regions under discussion, and these give us a good idea of the enormous scale on which some of the undertakings are made. The first part deals chiefly with the distribution of water, by the formation of reservoirs, and the subsequent building of canals. The question of wind and steam pumps then passes under review; here all kinds of types are mentioned, including an account of some of the more important artesian wells. Then follows the different systems adopted for actually distributing the water over areas, such as, for instance, a plantation; these vary according to the amount of water required. The statistics brought together show the enormous increase in the productive value of the land since the adoption of irrigation on a large scale. Under the heading of "Metallurgy," Roberts-Austen's and F. Osmond's researches on the structure of metals are translated.

IN the current number of the *Annales de Chim. et de Phys.*, M. Moissan gives an interesting account of his experiments on the volatilisation of refractory substances in the electric furnace. The sublimates were condensed on the outside of a curved copper tube placed two centimetres below the arc, and just above the substance under examination. A rapid current of water was passed through the tube, and kept it cool during the experiments, which usually lasted for about five minutes. The volatilised metals were copper, silver, platinum, aluminium, tin, gold, manganese, iron, and uranium. Quantitative experiments were not made in every case, but it appeared that manganese was sublimed more rapidly than the others, and that the rate of volatilisation of copper was about five times as rapid as that of gold. The condensed metal was usually, in great part, in the form of little spheres. Silicon and carbon were also volatilsed and condensed on the tube, though the amount collected of the last-named element was very small, and lime, magnesia, zirconia and silica were sublimed without difficulty. M. Moissan draws the conclusion that the most stable compounds hitherto known disappear in the electric furnace, being either decomposed or volatilised. Nothing resists these high temperatures except the series of perfectly crystallised compounds discovered by him, and consisting of borides, silicides, and, above all, carbides of the metals. M. Moissan intends to publish a description of these compounds shortly. He regards them as being probably among the original constituents of the globe, and as still existing in some of the stars.

THE earliest recorded measurements of the "dip" of the earth's magnetism were made in London by Robert Norman in the year 1576, and by Gilbert in 1600; but it was not until 1671 that this element formed the subject of a series of regular observations at Paris, indicating a continual diminution during the last two centuries from 75° to 65° 5′. In endeavouring to trace the secular variation of the dip, it is important to obtain, if possible, data extending over a far longer period. In a highly suggestive paper published in the *Atti dei Lincei*, Dr. G. Folgheraiter, taking as his starting-point the well-known property possessed by clay after it has been baked of retaining permanently any magnetisation that may have been induced in

it during the process of baking, advances the view that the various objects of terra-cotta discovered in excavations (vases, bricks, &c.) afford an indelible record of the state of the earth's magnetism at the epoch of their fabrication. The author, besides citing the observations of a number of physicists in support of his view, has put the matter to a practical test by examining the magnetisation of the bricks used in the construction of ancient villas, tombs, &c., at the time of the Roman Empire, of which the remains abound in Rome and the Campagna. It was found that the direction of magnetisation varied from brick to brick, some in the course of building having been laid with their axes of magnetisation in the opposite direction to the earth's magnetic force, some with their axes in the same direction, while others were magnetised normally to that direction; in no case did the axis of magnetisation correspond to any fixed direction, thus proving that the bricks had retained their polarity unaffected by terrestrial magnetism during the many centuries that have elapsed since the buildings were constructed. An examination of some Etruscan vases, dating from the eighth century B.C., leads to similar conclusions. In a tomb recently discovered at Narce (now Calcata), one of two vases was found magnetised in a nearly horizontal direction, the other exhibited a decided south pole at the bottom, and a north pole at the top, while two large *crateræ* had their north poles in the centre of the base, and their south poles in the orifice at the top. In a tomb at Falerii, two vases were found having the south pole in the centre of the base, while one "oinochoë" (wine measure), accompanying them, had the north pole at the upper extremity of its beak. From such evidence Dr. Folgheraiter considers himself justified in asserting with certainty that the direction of magnetisation observed in antique objects of terra-cotta is that due to the inducing effect of the earth's magnetism during the process of baking. In this, his first paper, the author draws no inferences relating to the earth's magnetism, but he points out a difficulty arises in most instances, owing to our uncertainty as to the orientation of the objects when originally placed in the kiln, a factor which must evidently be known before any definite conclusions can be stated.

THE August number of the *Proceedings* of the Geologists' Association contains a paper by Dr. Hicks on the Palæozoic Rocks of West Somerset and North Devon, in which are some original illustrations of the remarkable folds in the rocks of the Ilfracombe district. This is followed by a preliminary Synopsis of the Fauna of the Pickwell Down, Baggy, and Pilton Beds, by the Rev. G. F. Whidborne, in which brief descriptions of some seventy-four new species are included. The Rev. H. H. Winwood contributes notes on the Trias, Rhætic and Lias of West Somerset. These three papers have already been issued as the usual Long Excursion pamphlet. In addition the number contains a paper by Mr. A. E. Salter on the "Pebbly Gravel" of South-east England, and the relation of its distribution to the gaps in the present line of high-ground between Goring and the Norfolk coast; and one, by Mr. Strahan, on the physical geology of Purbeck and the relations of the anticlines to the watersheds in the south and south-east of England.

THE recent number of the *Proceedings* of the Liverpool Geological Society (vol. vii., part iv., dated 1896 only) contains an important presidential address by Mr. Mellard Reade, on British Geology in relation to Earth-Folding and Faulting; while a contribution to the same subject, in respect of the Craven district, is made by the Rev. F. F. Grensted. Among other papers of more than local interest we may mention Mr. Beasley's Attempt to classify the Footprints from the Trias of the district: Mr. Mellard Reade's Notes on the Drift of Mid-Wales; Mr. Lomas's Observations on Recent Glacial Striæ in Switzerland; and Dr. Callaway's Sketch of the Process of Metamorphism in the Malvern Crystallines.

Science for September 4 contains a lengthy appreciative article on Dr. P. L. Sclater, F.R.S., from the pen of Dr. G. Brown Goode.

THE Annual Report of the Keeper of the Manchester Museum has reached us, and is of a very encouraging character. During the year the Museum was recognised in a practical manner by the City Council as a public institution, for on October 16, 1895, a resolution was passed at a meeting of the Council that the sum of £400 a year should be granted to the Manchester Museum from the Free Library Rate. In November the experiment of opening the Museum for two hours on Sunday afternoons was first made. On the opening day, November 17, 494 persons attended. Since that date the attendance has varied from 131 to 797, the average being 519. During the year the Museum has received a large number of gifts from individuals and institutions.

VOL. XXVIII. of the *Transactions and Proceedings of the New Zealand Institute* (published in this country by Messrs. Kegan Paul and Co., Ltd.) is a bulky volume of 787 pages, and contains seventy-four articles classified as miscellaneous, or relating to zoology, botany, geology, and chemistry. In addition to these, reports of the proceedings of the incorporated societies are given, and the whole is enriched by thirty-seven well-executed plates.

THE Annual Report of the Calcutta Botanic Gardens, issued by the Superintendent, Dr. G. King, shows steady work and increase in efficiency in the various departments, notwithstanding the severe injury inflicted by the unusual drought of the summer months (October to March). The work of the herbarium has been carried on with vigour, a very large number of specimens have been added to it, while named specimens of Indian plants have been forwarded to various scientific institutions throughout the world.

THE *Botanical Gazette* records the establishment of a Biological Survey by the Department of Agriculture, under a recent Act of Congress of the United States, which it regards as the beginning of a new era in the botanical field-work of the States. The head of the new Survey will be Dr. Merriam, who has had great experience in the kind of work which it proposes to undertake.

THE corner-stones of the Hull Biological Laboratory of the University of Chicago were laid in July last. The Botanical Hall is expected to be finished by the spring of 1897, and, if we may judge from a sketch in the *Botanical Gazette*, will be a very imposing structure.

VOL. VI. part ii. of "Flora Capensis: being a Systematic Description of the Plants of the Cape Colony, Caffraria, and Port Natal (and neighbouring territories)," by various botanists, and edited by Mr. W. T. Thiselton-Dyer, is almost ready for publication by Messrs. L. Reeve and Co. Like part 1 of vol. vi., the present contribution is the work of Mr. J. G. Baker, the keeper of the Herbarium and Library of the Royal Gardens, Kew, and contains the continuation of the *Amaryllideæ* and part of the *Liliaceæ*, to the completion of which the whole of the third and concluding part will be devoted.

MESSRS. RIVINGTON, PERCIVAL, AND CO. will publish shortly, "Mechanics for Beginners treated Experimentally, embracing Statics, Dynamics and Hydrostatics," by L. Cumming, of Rugby School.

MESSRS. HENRY HOLT AND CO., New York, hope to issue at an early date a translation, by Prof. G. W. Field, of Brown University, of the first or "general" part of Dr. Hertwig's "Lehrbuch der Zoologie."

A NEW edition of Dr. Oliver Lodge's "Elementary Mechanics, including Hydrostatics and Pneumatics" has just reached us from Messrs. W. and R. Chambers, Ltd. It has been completely revised by the author and by Prof. Alfred Lodge.

MESSRS. TAYLOR BROTHERS, Leeds, have sent us the second edition of "The Collector's Manual of British Land and Freshwater Shells," by L. E. Adams. The preface states that the book has been re-written and brought up to date.

THE additions to the Zoological Society's Gardens during the past week include two Bonnet Monkeys (*Macacus sinicus*, ♂ ♀) from India, presented respectively by Mr. John Hart and Mr. E. E. Hodgskins; a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mr. Frederick Tomlin; a Mozambique (*Cercopithecus pygerythrus*, ♂) from South-east Africa, presented by Mr. A. C. Jackson; two Lanner Falcons (*Falco lanarius*), South European, presented by Mr. W. Glynes Bruty; a Glaucous Gull (*Larus glaucus*) from Franz Josef Land, presented by the Jackson-Harmsworth Polar Expedition; a Raven (*Corvus corax*), British, presented by Mr. O. L. Pegler; an Egyptian Jerboa (*Dipus ægyptius*) from North Africa, a Rat-tailed Serpent (*Trigonocephalus lanceolatus*) from St. Lucia, W.I., deposited; a Diana Monkey (*Cercopithecus diana*, ♀) from West Africa, three Capeira Partridges (*Odontophorus dentatus*) from Brazil, purchased; a Red Deer (*Cervus elaphus*, ♀) from Scotland, received in exchange; two Triangular-spotted Pigeons (*Columba guinea*), a White-backed Pigeon (*Columba leuconota*), two Half-collared Doves (*Turtur semitorquatus*) bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE RECENT SOLAR ECLIPSE.—M. Tisserand furnishes a few details on the results obtained by the Russian astronomers during the eclipse of August last, which were communicated to him through M. Backlund, Director of the Observatory of Pulkowa. M. Backlund's station was situated in Novaya Zemlya, where he landed three weeks before the day of the eclipse. During this period the sky remained constantly cloudy, the temperature varying from 0° to 3° C. During some occasionally bright moments altitudes of the sun were obtained to check their chronometers and determine their rates. M. Galitzine made a series of magnetic observations. At four o'clock on the morning of the eclipse the sky was still overcast, but the weather cleared up somewhat, and the observers were able to observe the four contacts under good conditions. Clouds, however, were not entirely absent; but successful observations and photographs of the corona were taken.

M. Eugène-M. Antoniadi, in the September number of the *Bulletin de la Société Astronomique de France*, gives an account of his trip in the *Norse King* to Vädso. The article in question is illustrated, and contains, among others, a drawing of the region in and about Vadsö, and an excellent photogravure of the town of Hammerfest.

COMET BROOKS.—A Centralstelle Circular, dated September 10, gives an ephemeris, with elements, of this comet computed by Prof. E. Lamp from observations made on September 7, 8, and 9. They are as follows:—

Elements.

$$T = 1896 \text{ July } 7{\cdot}278 \text{ Berlin M.T.}$$
$$\left.\begin{aligned} \omega &= 38^\circ\ 22' \\ \Omega &= 149^\circ\ 22' \\ i &= 88^\circ\ 16' \end{aligned}\right\} 1896{\cdot}0$$
$$\log q = 0{\cdot}06497.$$

Ephemeris 12h. Berlin M.T.

1896.	α h. m.	δ ° ′	log Δ	B.
Sept. 16	14 55·9	+53 15	0·2405	0·9
20	15 21·0	51 53	0·2428	0·8
24	15 44·7	50 16	0·2463	0·8
28	16 6·9	48 26	0·2512	0·7
Oct. 2	16 27·6	46 29	0·2574	0·7
6	16 46·7	44 25	0·2650	0·6

The unit of brightness occurred on September 4.

COMET GIACOBINI.—A circular from Kiel, dated September 9, gives the elements and ephemeris of this comet calculated by Dr. H. Kreutz from observations on September 5, 6, and 7.

Elements.

$$T = 1896 \text{ October } 8{\cdot}003 \text{ Berlin M.T.}$$
$$\left.\begin{aligned} \omega &= 155^\circ\ 2'{\cdot}1 \\ \Omega &= 195^\circ\ 39'{\cdot}5 \\ i &= 8^\circ\ 45'{\cdot}2 \end{aligned}\right\} 1896{\cdot}0$$
$$\log q = 0{\cdot}04004$$

These elements are stated to be somewhat uncertain. The orbit is probably an ellipse.

Ephemeris 12h. Berlin M.T.

1896.	α h. m.	δ ° ′	log Δ	B.
Sept. 7	17 16·5	− 8 0	9·785	1·1
11	17 25·1	− 8 41	9·772	1·2
15	17 35·0	− 9 24	9·757	1·3
19	17 46·4	− 10 10	9·742	1·4
23	17 59·3	− 10 58	9·050	1·6
27	18 13·9	− 11 47	9·709	1·8

NEW FEATURE ON MARS.—With reference to the recent observation of bright light on the terminator of Mars, referred to on September 3, we may state that the bright prominences (mountains?) on the terminator of Mars were first seen by the astronomers of the Lick Observatory in 1890, and have been regularly observed (measured) at subsequent oppositions by the observers at Mount Hamilton, Nice, and Flagstaff.

Prof. Hussey observed their first appearance in 1896 on August 28, 0h. 45m. Greenwich mean time, in the *Chersonesus* region of Mars.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

IT is announced that a sum of between £15,000 and £17,000 is to be spent in providing buildings and fixtures for the Sunderland Technical College.

AMONG recent appointments we notice the following:—Mr. Lake becomes Principal of the Technical and University Extension College, Colchester; and Mr. J. W. B. Adams, Head-master of the Tenby and Intermediate and Technical Schools.

MR. A. M. DRENNAN, of the Burnley Grammar School, has been appointed Head-master of the Banbury Municipal Secondary and Technical School.

AMONG recent appointments abroad may be mentioned:—Prof. W. Dames to succeed the late Prof. Beyrich in the chair of Geology and Palæontology at Berlin; and Dr. W. Wien, to be Associate Professor of Physics at Berlin.

THE Chemical Laboratory of the University of Illinois has been destroyed by fire. It is reported to have been one of the largest and best-appointed of its kind in the country, and was erected at a cost of about £8000. Its fittings, apparatus, &c., are said to have added to this amount about £7000.

THE Syllabus of the Municipal Technical School and Municipal School of Art, Manchester, for the forthcoming session is now ready. It is issued by Mr. John Heywood, Manchester. The Calendar for the twelfth session of the Merchant Venturers' Technical College, Bristol, is also ready, and may be had, at a small charge, of Mr. H. Y. Hill, Bristol. We have also had sent to us the prospectus of day and evening classes to be conducted at the Battersea Polytechnic Institute. Copies may be obtained on application to the Secretary.

THE fifth annual report of the Department of Agriculture of the Yorkshire College, Leeds, is a record betokening much activity. Most of the lecture courses appear to have been well attended, though in the teachers' agricultural classes the attendance fell off so considerably that it was found impossible to hold a summer vacation course. In the winter courses the same difficulty was experienced, and though attempts were made to form classes at five centres, it was only possible to obtain sufficient students to form one class. At the request of the West Riding County Council, the department formulated a scheme for the institution of gardens for instruction in horticulture in connection with evening continuation schools. The scheme has been adopted by the West Riding County Council, and grants have been promised by them provided certain regulations are complied with.

SCIENTIFIC SERIAL.

American Journal of Science, September.—On the regular or specular reflection of the Rontgen rays from polished metallic surfaces, by O. N. Rood. Platinum foil at an angle of incidence of 45° reflects $\frac{1}{200}$th part of the incident X-rays. About half the rays are reflected in a regular geometrical or specular manner, as proved by photographs of iron gratings obtained by means of the reflected rays, and compared with photographs obtained with the same mirrors by means of ordinary light, diffused or radiating from a point. But the proportion of regularly reflected rays is less than in the case of ordinary light. There is a greater proportion of diffused rays, but these are diffused, not as they would be by a dull surface, but as they would be by an imperfectly polished surface. Similar results were obtained with speculum metal and tinfoil.—An iodometric method for the determination of phosphorus in iron, by Charlotte Fairbanks. Phosphorus may be determined in iron by precipitating the ammonium phospho-molybdate according to the usual methods of iron analysis; then reducing the phospho-molybdate thus obtained with potassium iodide and hydrochloric acid; neutralising the residue with acid sodium carbonate, and reoxidising with standard iodine.—Is the land round Hudson Bay at present rising? by J. B. Tyrrell. The reasons advanced by Dr. Robert Bell for supposing that the land round Hudson Bay is still rising are not conclusive. The land at the mouth of the Churchill River has been unchanged for the last century and a half. Sloops Cove, where the sloops engaged on the Eskimo trade used to winter, has many inscriptions of the middle of the eighteenth century, whose position, when compared with their exact date, shows that they would not have been hewn into the rock at the level they occupy if the tides had at that time attained a higher level than they do now.—A visit to the Great Barrier Reef of Australia, by A. Agassiz. The expedition, supported by the United States, the British, and the Queensland Governments, was equipped for extensive pelagic fishing and topographical surveying inside and outside the Barrier Reef. Boisterous weather made pelagic fishing very difficult, and the explorers had to content themselves with an examination of the inner portions. The slope is greatest in the southern portion, where the channel is wider. There is evidence to show that the islands composing the reef formerly filled up the channel as well. The islands lining the continent were the last to disappear. The very moderate subsidence which has taken place in comparatively recent times cannot have shaped the outlines of the present Australian continent, and of its submarine extension. For this we must look back, first to the subsidence which took place in Cretaceous times, next to the subsequent elevation of the Cretaceous beds, and finally to the erosion and denudation to which these beds, since their elevation above the level of the sea, have for so long a period been subjected. It is on the upper part of these submarine slopes, dating back to an earlier geological period, but modified by erosion and denudation up to recent times, that during the present epoch corals have obtained a footing and built up the Great Barrier Reef of Australia.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 7.—M. A. Cornu in the chair.—Notice on the late Amé-Henry Resal, by M. Maurice Levy.—On the observations of the eclipse of the sun of August 9 last. Extract from a letter to M. Tisserand by M. Backlund, Director of the Observatory of Pulkowa. Athough for some time preceding the eclipse the weather had been extremely unfavourable, the first contact was observed in a perfectly clear sky, and a dozen good photographs were obtained.—Memoir on the thermo-chemistry of the oxygen compounds of phosphorus, arsenic and sulphur, by M. Marcellin Langlois.—On the steering of aërostats, by M. Rozier.—On the employment of a fixed circle, derived from any group of seven tangents to a conic, to define, *à priori*, the circle derived from any seven right lines, by M. Paul Serret.—On the distribution of deformations in metals submitted to stresses, by M. L. Hartmann. A reply to some remarks by M. Charpy.—Discharge of electrified bodies by the X-rays, by M. E. Villari. The experiments described tend to show that the discharge of electrified bodies is not brought about by the X-rays themselves, but by the air rendered active by their passage.—On the emission of the X-rays, by M. C. E. Guillaume. A theoretical proof of the laws of emission established experimentally by MM. Imbert and Bertin-Sans, and by M. Gouy.—On the general relation between the intensity of sensation and the duration of a luminous impression, by M. Charles Henry.—On some questions in celestial mechanics, by M. A. Karagiamides.—On nervo-psychosis, by M. Bouxteieff.

SYDNEY.

Royal Society of New South Wales, June 3.—Mr. J. H. Maiden, President, in the chair.—The following papers were read:—On periodicity of good and bad seasons, by Mr. H. C. Russell, C.M.G., F.R.S.—The Mika operation of the Australian Aborigines, by Prof. Anderson Stuart.—The absorption of water by the gluten of different wheats, by Mr. F. B. Guthrie.

July 1.—Mr. J. H. Maiden, President, in the chair.—Discussion upon the paper read by Mr. Russell at the preceding meeting.—Notes on recent developments of Röntgen rays, by Prof. Threlfall.

August 5.—Mr. J. H. Maiden, President, in the chair.—Papers read:—On the occurrence of a submerged forest with remains of the dugong at Shea's Creek, by Mr. R. Etheridge, jun., Prof. T. W. E. David, and Mr. J. W. Grimshaw (with exhibits).—On aromadendrin or aromadendric acid from the turbid group of *Eucalyptus kinos*, by Mr. Henry G. Smith.—On the cellular kite, by Mr. Lawrence Hargrave (with exhibit).—Note on a method of separating colloids from crystalloids by filtration (with demonstration); also an explanation of the marked difference in the effects produced by subcutaneous and intravenous injection of the venom of Australian snakes, by Dr. C. J. Martin.—Mr. H. G. Smith exhibited a specimen of Lapidolite (*Lithia mica*) from near Norseman, West Australia.

CONTENTS.

THURSDAY, SEPTEMBER 24, 1896.

BABYLONIAN MAGIC AND SORCERY.

Babylonian Magic and Sorcery. By L. W. King, M.A. Pp. xxx + 199. (London: Luzac and Co., 1896.)

IT is clear from the seventy-five plates of cuneiform texts with which Mr. King has furnished his book, that he addresses himself mainly to the little group of cuneiform scholars who in England, America, and Germany are pushing on their science with strenuous endeavours; but those who take the trouble to read his translations of these texts, and his remarks upon the same, will at once see that he is in reality speaking to a much larger audience—namely, to all those who take an interest in the science of the ancient religions of the world, and to those who spend their time in tracing the development of the sister subjects of magic and sorcery from the earliest ages to the present day. The foundation of all real study in comparative religion must, after all, be the documents which the priests wrote, and the copies of them which the scribes attached to the temples made for their use; no student of anthropology can afford to neglect the evidence obtained from these sources, and the student of comparative religion who ignores them imperils both his credibility and reputation. Further, all schemes of the religions of ancient nations which are drawn up without due consideration of every available document must be defective, and are, probably, useless, and no man should theorise without his sheaf of facts, that is to say his ancient texts, at his elbow. It is now some sixty years since Rawlinson and Lassen found the key which unlocked our storehouse of native Babylonian and Assyrian information on this subject; and yet until within the last five years we possessed very little exact information concerning the religious beliefs of the Babylonians and of the people of the more northerly country of Assyria. We had translations of hymns and of documents which were clearly of a religious nature, but they afforded us no real insight into the system of religion which existed in Mesopotamia in the earliest times; moreover, both texts and translations were generally fragmentary and disconnected, and in cases where they were not so the reader was puzzled, and could not guess their true significance. Little by little, however, as students devoted themselves to the subject, it was found that the text on a tablet was not necessarily complete in itself, and soon it was recognised that many tablets were needed for copying a religious work, or, as we might say, "service." Next it was found that certain parts of the texts consisted of rubrical directions, and then it was known that we had become the fortunate possessors of copies of the "service-books" which were probably in use in Babylonia several thousands of years before Christ. Most of these copies were made by the order of the great King Assur-bani-pal (Asnapper), for use in his Royal Library at Nineveh in the seventh century B.C.; and, as a large number of words, names, and phrases in them were in the agglutinative language of the non-Semitic peoples of Mesopotamia, it was pretty clear that the king had had these compositions translated from it into his own Semitic speech. We now know that the ancient peoples of Mesopotamia possessed a series of legends concerning the Creation of the heavens and of the earth and of all that is therein; a series of legends of the deeds of the mythical hero Gilgamish; and a series of mythological stories. They had formed in their imagination an abode for the gods, and an underworld wherein the souls of the dead had their place together with the infernal gods. They had, at an early date, formulated a great trinity of Anu, Ea and Bel, and they gave to one of their gods, at least, the attribute of mediator and intercessor between men and their god. They believed in the efficacy of prayer when accompanied by certain ceremonies, and in brief they held many religious ideas and beliefs in common with their cousins the Hebrews. Whether they ever succeeded in establishing a personal relation with their god or gods, is open to doubt; but the texts which Mr. King has published lead us to think that a development in this direction was going on when the Assyrian Empire was overthrown. The group of compositions which Mr. King has edited belongs to a class of texts which are known to scholars as the "Prayers of the Lifting of the Hand," and all of them were written for the use of individuals, the name of the suppliant at times being given. Many prayers to be efficacious must be accompanied by an offering of some object to the god, and it was necessary that the rubrical directions should be strictly adhered to; certain prayers were, however, only potent at certain times—as, for example, on a lucky day, or at night, or during a certain phase of the moon. It is probable, too, that, as in ancient Egypt, the correct recital of a prayer was deemed of the first importance, and that any prayer offered without the burning of incense was in vain. The use of fire in the accompanying ceremonies was common and of the utmost importance, and its purifying properties were well understood; and as the flame consumed the object which the suppliant, or the priest on his behalf, cast into it, so the disease, or calamity, or trouble vanished straightway. The part played by fire in certain religious ceremonies was so prominent that two series of inscribed Assyrian tablets were called *Shurpu* and *Maklū* respectively; both these names mean "burning." As a specimen of a petition, we quote the following lines from an address to Ishtar:—

> "Have mercy on me, O Ishtar! Command abundance.
> "Truly pity me and take away my sighing. . . .
> "I have borne thy yoke: do thou give consolation. . . .
> "I have sought thy light: let thy brightness shine.
> "I have turned towards thy power: let there be life and peace. . . .
> "Speak, and let the word be heard.
> "Let the word I speak, when I speak, be propitious.
> "Let health of body and joy of heart be my daily portion.
> "My days prolong, life bestow: let me live, let me be perfect, let me behold thy divinity.
> "When I plan, let me attain (my purpose): Heaven be thy joy, may the Abyss hail thee."

When these words had been said an offering of incense and a drink-offering were set before Ishtar, and the suppliant raised his hand three times.

Our space will not admit of further quotation from this interesting work, and we have only to add, for the in-

formation of the general reader, that it should be studied in connection with the recent works of Tallqvist and Zimmern on the *Maklû* and *Shurpu* series of tablets in the British Museum. A word of praise is justly due to Mr. King for his honest work, and although the introduction might have been fuller with advantage to the reader, the translations, and transliterations, and vocabulary will help to make the texts at the end of the book understood by every careful reader.

MICRO-ORGANISMS AND DISEASE.

Micro-organisms and Disease; an Introduction to the Study of Specific Micro-organisms. By Dr. E. Klein, F.R.S. New edition. Pp. xii + 595. (London: Macmillan & Co., Ltd., 1896.)

THE rapid strides which have been made in bacteriological science during the last few years render the frequent revision of the text-books on the subject a necessity. It is a noteworthy fact that although bacteriology is one of the newest of the sciences, it is rapidly becoming so large a subject that specialisation in one branch or other of it is almost essential.

Dr. Klein's book treats mainly of that particular branch of bacteriology which deals with "pathogenic" micro-organisms, including only a very small number out of the total known species. Other branches of bacteriology have also their specialised handbooks—*e.g.* the micro-organisms in water are sufficiently numerous and well-known to require a text-book to themselves, whilst it would be easy to mention other branches of the subject which will soon require similar treatment. In this new (third) edition of Dr. Klein's work we find the subject brought practically up to date. The present edition is enlarged to 595 pages, as against 267 pages in the previous one. There are 80 additional illustrations, as compared with the last edition, making 201 in all. Amongst them are inserted, for the first time, a number of well-reproduced photographs of cultures and of excellent stained preparations of bacteria, taken by the well-known photomicrographers Messrs. Pringle and Bousfield. These are almost uniformly good, but photographs, such as Fig. 63A, mar an otherwise fine series.

The introductory chapters deal with bacteriological technique, such as the preparation of culture media, stained microscopic preparations, methods of inoculation and cultivation, bacteriological examination of water, air and soil. Then follows a full discussion of the general characters of bacteria—more especially of the pathogenic organisms—in which their mode of growth, spore formation, means of motility, &c., are discussed.

The chapter on "The Chemistry of Bacteria," confined as it is to a dozen pages, merely serves to show how meagre is the bacteriologist's knowledge of this part of the subject. It is a chapter, however, which might easily be amplified with advantage. For example, in writing on the liquefaction of gelatine, no mention is made of the fact that such liquefaction is due to an enzyme, and that it can be brought about by the agency of sterile filtered cultures of liquefying bacteria, apart from the bacteria themselves. Similarly, no reference is made to other enzymes, such, for instance, as those which bring about the hydrolysis of starch, &c.

A brief glance at the succeeding chapters will show how extensive is the list of diseases which are associated with specific micro-organisms. To mention only a few of the best known, we find considered in this book—often very exhaustively—typhoid, cholera, tuberculosis, tetanus, diphtheria, influenza, erysipelas, pneumonia, gonorrhœa, anthrax, glanders, relapsing fever, fowl cholera, grouse disease, Oriental plague, &c.

In the concluding chapters we find an epitome of the latest results of the labours of many workers in the field of serum therapeutics, a subject which is just now attracting so much attention from medical men and bacteriologists, and the experimental results of which are of the most far-reaching importance. The newest methods of research are clearly set forth, and the results obtained by recent workers are fully discussed.

Dr. Klein's views on the proper interpretation of the results of researches in various branches of his subject are frequently at variance with those of other authorities, yet it is refreshing to find—in these days of the premature publication of incomplete work—an author who is ready to stand out for a logical proof of the correctness of conclusions which are often drawn from meagre and incomplete evidence. There is no one in this country whose views on various controversial matters, coming within the scope of the book, are more entitled to careful consideration than are those of Dr. Klein.

The latest methods of protective inoculation by antitoxic blood serum, more particularly in diphtheria and tetanus, are noticed and discussed. In this connection one regrets that more space is not devoted to the closely related subject of snake-poison and its antidote. The methods pursued are so similar, and the results already achieved are so important, that the subject might easily be brought within the scope of the book, especially as such diseases as cancer are included, although a disease which is most probably not associated with micro-organisms.

Under the heading of "Protozoa causing disease" is found a valuable discussion of the vexed question of the parasitic or non-parasitic nature of cancer. Dr. Klein shows very clearly the kind of fallacy into which the "parasitologists" and discoverers of "cancer organisms" have easily fallen.

Bacteriology has, during the last few years, become more and more complex. Where a single organism was previously recognised, it is now becoming certain that there are very many modifications and sub-varieties of each, which can only be differentiated and distinguished from each other by difficult methods. Nowhere is this more obvious than in reading the chapters containing descriptions of *Bacillus coli communis* and of the typhoid and cholera organisms.

The book is beautifully printed, and, with a few exceptions, the illustrations merit great praise.

There seem to be very few misprints. On p. 89, however, a reference is made to the work of Downes and Lunt; this should, of course, be Downes and Blunt. Also, on pp. 588 and 595, Vehring is inserted for Behring.

The author is to be congratulated on the completion of this revised and much enlarged edition of his valuable book, which ought to be in the hands of every medical man.

JOSEPH LUNT.

OUR BOOK SHELF.

Text-book of Zoology. By Dr. J. E. V. Boas. Translated by J. W. Kirkaldy and E. C. Pollard. Pp. xviii + 558; with 427 figures. (London: Sampson Low, Marston, and Co., Ltd., 1896.)

THE "Text-book of Zoology," by Dr. Boas, which is now presented to English students in this country in the form of a translation by Miss Kirkaldy and Miss Pollard, has this advantage over many similar books at present in use, that it is complete in one volume. The translators have done their work well in keeping closely to the German text, and in forming clear and concise English sentences made up of English words. Regarded simply as a translation of a German book, it is far better than most of its predecessors, and the translators may be congratulated upon their share of the work. But the book is not one which English teachers will be able to recommend to the "beginners in the study of zoology" who attend their classes, notwithstanding many excellent features which may be found in several chapters. It would be difficult for them to heartily recommend to their students, as a guide to their studies, a book which classifies Limulus with the Entomostraca, and Peripatus with the Annelida; nor can they consider it to be complete, even for elementary work, in the absence of any account of such important forms as Balanoglossus, Rhabdopleura and Phoronis.

Apart from these blemishes of primary importance, there are many others which detract very considerably from its value as a text-book for students. The description of Amphioxus, for example, is so short, and the figures so poor and inaccurate, that no beginner could possibly recognise the importance and interest of the group to which it belongs. The same may be said of the group Tunicata, which is described in four pages at the end of the Vertebrata, and illustrated by only four very poor figures.

The book, moreover, is disfigured by many strange blunders and inaccuracies, of which a few may be given. The rich animal fauna of the deep sea does *not* "resemble the cave fauna." Alcyonium is *never* dimorphic; there is *no* chitinous perisarc in Millepora, which is calcified; *Hirudo medicinalis* is *not* indigenous in England. Nor is the book thoroughly up to date in many particulars. The account given of the gills of Lamellibranchiata might have been written fifteen years ago. The results of Leche's important work upon the succession of mammalian teeth are not even briefly mentioned. Nor can the account of the epidermal structures of Vertebrata be said to be complete when no reference is made to Prof. Weber's extremely important observations on the scales of Manis.

It is possible, however, that some teachers in this country may find the book useful for occasional reference. Some of the diagrammatic figures are new and fairly accurate. The introductory chapters on cells and tissues and on embryology are excellent, and some of the chapters on vertebrate animals are better than in any modern text-book of zoology with which we are acquainted.

The Antichrist Legend: a Chapter in Christian and Jewish Folk-lore. Englished from the German of W. Bousset, with a Prologue on the Babylonian Dragon Myth. By A. H. Keane. Crown 8vo. Pp. xxxi + 307. (London: Hutchinson and Co., 1896.)

AT various intervals certain well-meaning individuals, with enthusiasm inversely proportional to their knowledge, attempt expositions of such extremely difficult texts as the Books of Daniel and Revelation, and they glibly profess to explain the Antichrist, and are impressive on the Beast. They little realise that, as Bousset says, "to understand Revelation we need a fulness of eschatological and mythological knowledge." One has only to glance through Bousset's erudite work to be convinced that it is only by the most patient and learned research that such problems can be solved, and so we welcome Mr. Keane's translation of this valuable study, and hope (probably in vain) that the latter-day prophets will cease to yield to the temptation of giving free play to their fancy, and will investigate the historical growth of legendary beings, and thus eventually become students of folk-lore. It is evident, from the researches of Bousset and Gunkel, that Belial, the Antichrist, and the numerous other variants of Christian and pre-Christian authors, are adaptations of the ancient Babylonian Dragon myth. Mr. Keane goes a step further back, and attempts to account for the origin of this myth. He suggests that it refers to the first settlements on the low-lying plains of Chaldæa, when man had to contend against the periodicial freshets of the Euphrates and Tigris, caused by the melting of the snows of the watersheds, and against huge crocodiles which infested the estuaries. "There could be no peace or progress until the waters were quelled (confined within their banks, and diverted into irrigation canals), and until their presiding genius (the reptile or dragon, "lord of chaos") was overthrown. . . . Then the foremost champions engaged in these contests acquired their apotheosis in the minds of a grateful posterity, while the vanquished enemy assumed more and more the form of unearthly monsters and demons hostile to man. Such memories easily passed on from generation to generation until they acquired consistency and permanency in the written records of the cultured Babylonian peoples."

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Utility of Specific Characters.

I TRUST you will give me space—not to continue this discussion—but to correct an error in Mr. Dyer's last letter to you. Mr. Dyer states that I consider that Prof. Weldon's investigation of the crab's carapace "does not satisfy the canons of scientific inquiry." I have made no statement to that effect, and am surprised that Mr. Dyer should put such a phrase into my mouth.

I am, I believe, almost as fully acquainted with the details of Prof. Weldon's work, and the laborious measurements carried out by him in the laboratory at Plymouth and in University College, as is Mr. Dyer. I have never spoken of nor regarded the actual results obtained by Prof. Weldon as otherwise than interesting and valuable. My difference with Prof. Weldon is, as I explained (I thought with sufficient clearness) in my first letter to NATURE on this subject, one as to the interpretation put by him on these results. I do not consider that he is warranted in declaring that a particular frontal proportion of the carapace is effective in securing the survival of those crabs possessing it. Moreover, I do not agree with him in holding it to be "absolutely illogical" (as he expressed himself at the Linnean Society) to entertain the hypothesis that one or more structures in a "surviving" or "naturally-selected" organic form may be effective in bringing about that survival or selection whilst other structures may vary concomitantly with these and be inoperative in effecting the survival.

E. RAY LANKESTER.

Utrecht, September 18.

The Position of Science at Oxford.

ON my return to Oxford my attention has been called to an article which appeared in your issue of July 9 last, bearing the above title. (By science is meant, of course, natural science.) I do not wish to discuss the whole of the article. It is for the most part temperately written, and contains some useful criticism by which we in Oxford may profit.

One of its main contentions, however, is this—that hardly any of the colleges at Oxford do much, and that none do more than they are obliged, to encourage natural science by means of their endowments.

I think that if I may be allowed briefly to state what the college which I know best, and the only one for which I have a right to speak, is doing in this matter, it will enable your readers to see that this contention is not universally applicable, and that there are at least some exceptions with regard to which the writer seems very imperfectly informed.

Magdalen College is spending at this moment in the direct endowment of natural science through professorships, fellowships, scholarships, and exhibitions, over £3500 a year, besides maintaining a laboratory of its own, and subsidising in other ways the teaching of natural science both in the University and within its own walls.

We support four professors of natural science. It may be said that we are obliged by statute to do so. That is true, but we were not bound to establish these professorships as rapidly as we have done, and we have been obliged at times to suspend fellowships in order to do so. We have, besides our four professor-fellows, three other fellows on our Governing Body voluntarily elected by the college for natural science.

The writer of the article complains that so few colleges have even a single tutor in natural science. More than twenty-five years ago we started a tutor, and for the last dozen years we have had a lecturer as well in natural science upon our regular staff.

We are not absolutely bound to offer any scholarships for natural science. We have always offered one a year ever since our demyships were thrown open, and we have frequently elected two and sometimes three demies in natural science in the same year, and often exhibitioners as well. Of the two senior demies, which are all we can at present afford ourselves, one was elected for natural science.

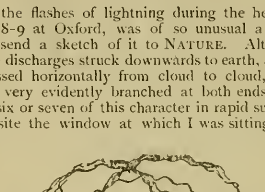
I believe that several other colleges at Oxford could point to facts analogously ignored or underrated by the writer of the article. What I have stated will at any rate, I think, show that my college, which was barely alluded to by him, has not been backward to recognise the claims or encourage by endowment the study of the natural sciences at Oxford.

T. HERBERT WARREN.

Magdalen College Oxford, September 17.

A Remarkable Lightning Flash.

ONE of the flashes of lightning during the heavy storm of September 8-9 at Oxford, was of so unusual a form that I venture to send a sketch of it to NATURE. Although a good many of the discharges struck downwards to earth, a considerable number passed horizontally from cloud to cloud, and most of these were very evidently branched at both ends. There had been some six or seven of this character in rapid succession in a cloud opposite the window at which I was sitting, and after a



Lightning Flash at Oxford, at about 12.45 a.m. September 9.

pause of two or three minutes I saw the appearance I have tried to represent. From the red glare by which it was surrounded, it was evidently within the cloud, but it was so dazzlingly bright that the after-image remained visible long enough for me to trace the convolutions and sketch them from memory. The main body of the flash made one complete loop, and the two ends, which were much branched, nearly completed a second turn. It appeared almost due north, about 35° above the horizon, and might have been comprised within a circle of about 5° in diameter. Evidently the path of the flash was an irregular spiral, and, with the exception of the branched ends, it looked exactly like the discharge of a large induction coil, seen end on. I much regretted not being provided with a camera.

GEORGE J. BURCH.

21 Norham Road, Oxford, September 9.

A Peculiarity in Perch.

I VENTURE to bring the following observation before the readers of NATURE, because I believe it to be uncommon, and that it will be a matter of interest to naturalists. My brother, whilst fishing in a pond in East Lancashire, caught twelve perch, the smallest weighing 3 ozs. and the largest 10 ozs., and eight of them exhibited a very marked peculiarity.

On the left side of the fish the cover of the gill was very small, being only less than half the natural size, and as a consequence a large portion of the gill was exposed. The largest fish presented this appearance.

The remaining four had covers to their gills, perfectly normal and similar on both sides.

The peculiarities about this malformation are that it apparently is confined to the gill-cover on the left side of the head, the one on the right side being perfectly normal; and is only to be found in certain of the fish in the pond.

It may possibly be the result of a disease; but if this is the case, the fact of it affecting always the same gill-cover appears somewhat remarkable, and to my mind is more than a coincidence. Besides every part of the fish, including the gill-cover itself, appears to be perfectly healthy.

The water has no predominant feature, and gives on analysis results similar to any common spring-water. I have known at rare intervals water containing iron to be discharged into the pond, but this has been almost immediately noticed and prevented.

As I have been unable to find an account of any disease exhibiting such a characteristic as above described, I have come to the conclusion that it is a very peculiar malformation of the cover of the gill. I should be glad to have some further information respecting this phenomenon if any reader of NATURE is in a position to give it.

R. J. FLINTOFF.

The Siemens Gas and Coke Fire.

I HAVE had a Siemens gas and coke fire in my study for fifteen years. There was much trouble in getting it put in properly, and Sir W. Siemens kindly advised me about it. It burns very little gas, and the coke is cheap. The gas is only used to kindle or liven up the coke. Everybody admires the beautiful fire it makes, and there is no smell and no smoke. The coke requires to be broken to the size of a small apple, and it is needful to clear out the bottom of the fire. I do this with an iron shovel, and thus remove the ash which, without this removal, would choke the fire. It is the neglect of this essential process which makes the Siemens fire sometimes a failure. Mine is, in all respects, a brilliant success.

P. W. CLAYDEN.

13 Tavistock Square, September 18.

P.S.—I read of the grate in NATURE in 1880, saw it at the Smoke Abatement Exhibition in 1881, and adopted it at once.

THE LIVERPOOL MEETING OF THE BRITISH ASSOCIATION.

V.

LIVERPOOL, *Wednesday.*

THE dominant note throughout this meeting has been "Listerism"—the germ theory, the application of biology to medicine. The reception given to the President by the people of Liverpool, especially by the medical profession, has been splendid and enthusiastic. The Philharmonic Hall was crowded to the doors by an attentive and appreciative audience on the occasion of the Presidential Address; and the vote of thanks was most appropriately and happily proposed by the Lord Mayor (Lord Derby), and seconded by Sir William Turner, an early friend and colleague of the President.

This is a large meeting, the total number will probably nearly reach 3200, and this will place it as one of the few largest meetings of the Association; it has certainly been one of the busiest and liveliest. The hospitality of Lord Derby, both at the Town Hall and at Knowsley, and the banquets given by the Medical Institution and the American Chamber of Commerce, have been much appreciated.

Notwithstanding the unsettled weather, the garden parties have been largely attended, and have constituted a most agreeable and welcome method of meeting the members of other Sections.

St. George's Hall has been much admired as an unequalled reception-room; and with its new decoration, its beautiful tiled pavement, the electric light, the grand organ, and the crowd of people constantly passing to and fro, has presented a gay and lively scene.

At the Sectional meetings, although there has been nothing sensational, there is much evidence of solid work, and many interesting discussions, such as that on the Röntgen rays, in Section A, where Lenard is a notable figure, and the joint discussions of Sections D and I, on the origin of Vertebrates, following Prof. Gaskell's interesting address.

Among some of the other more interesting events in the Sections which seem to be attracting public attention were Prof. Ramsay on Helium and Argon, Prof. Dewar's account of liquid air, in Section B, the series of arctic papers, including Sir Martin Conway's lecture on Spitzbergen, and Mr. Scott Keltie's account of Nansen, in the Geographical Section, and the discussion, in Section H, on the Mediterranean race and the origin of Mycænean culture. Other attractive items before the Anthropological Section were the question of the age of the Dolmens, opinion being divided as to whether they belong to the Bronze or the Neolithic period, and the discussion on the femur of *Pithecanthropus*, a comparison of this celebrated bone with the femora of savage races showing that all its special characters are already known in human femora. The Section celebrated in an interesting manner the centenary of the Swede, Retzius the elder, the originator of modern methods of craniology.

One characteristic of the Sectional meetings has certainly been the extreme fulness of the programme, the result being that some Sections have had to meet early and continue sitting late; most of them held meetings on the Saturday, and several will have to continue their work well into the Wednesday forenoon.

Mention need not be made of the other scientific communications, as the usual special account of the work of the Sections will appear in future issues of NATURE.

The two conversaziones were brilliant functions, and the impression amongst the visitors seemed to be that the public rooms in Liverpool were very fine in dimensions and decoration. At the first soirée—that given by the Lord Mayor—there were no adventitious attractions beyond the stately reception and the pleasant meeting of friends. At the local committee's soirée in the Museum Library and Art Galleries, where ample accommodation is available, there were short lectures, demonstrations, and various exhibits which attracted much interest. Perhaps one of the finest exhibits was the great collection of models of ships lent by the Cunard, White Star, and other great ocean lines.

Between forty and fifty foreigners have been present, amongst the more notable figures being the botanists, Chodat, Pfitzer and Magnus; the physicists, Lenard and Kohlrausch; the archæologist, Montelius; and the zoologists, Hjort, Delage, and Minot. We have also had de Candolle, Le Conte, Dupuy, Walther, and Count Pfeil.

The Loan Collection in the new Museum of Zoology at University College seems to have been much appreciated. The exhibits in the collection chiefly illustrate papers read before Sections C, D, and H, and several of the Sections have adjourned in the afternoons to the Museum for special demonstrations.

On Saturday, notwithstanding the unsettled weather, all the excursions arranged were successfully carried out, including the dredging expedition in the Lancashire Sea Fisheries steamer, in which a number of the foreigners took part. The applications for the Thursday excursions are sufficiently numerous. The Isle of Man seems to be the favourite one, and as this is to be an expedition of considerable scientific interest, with a carefully-arranged programme, including nearly all the objects worthy of special attention in the island, a further report on the results of the excursion will be given in a future number of NATURE.

On Association Sunday, the usual arrangements were made, and several selected preachers dealt with the inter-relations of religion and science and other subjects which were supposed to be appropriate to the occasion. Amongst those who preached were Dean Farrar, Mr. Lund, Canon Diggle, Dr. Klein, and Prof. Ryle, of Cambridge. Many of the members of the Association seemed to prefer short trips in the neighbourhood of Liverpool, or to take advantage of the pleasant hospitality that was offered by some of the owners of large houses and gardens in the afternoon and evening.

At the meetings of the General Committee, several important matters have been decided. The date of the commencement of the meeting at Toronto next year has been fixed for August 18. The President-elect is Sir John Evans, K.C.B. The list of vice-Presidents and the local officers have also been fixed upon.

The Secretary of the Toronto Committee made a preliminary statement as to the facilities offered by the great steam ship companies in crossing the Atlantic, and the Committee have already distributed to members of the Association a most attractive preliminary programme in the form of a richly-illustrated pamphlet of seventy pages. Further details in regard to the arrangements for crossing the Atlantic, and also for travelling to America, are promised shortly.

With regard to the meeting in 1898, it seemed likely at one time that there would be competition between Glasgow and Bristol. A distinguished deputation from each City Council attended this meeting; but at the last moment the Lord Provost of Glasgow gracefully withdrew his claim in favour of Bristol, which had already made considerable preparations, and had been first in the field; consequently Bristol, on the motion of Sir. F. Bramwell, seconded by Prof. Ramsay, was unanimously fixed upon as the place of meeting for 1898. It was further resolved that the meeting in 1899 be held at Dover, in conjunction with the meeting of the French Association at Boulogne, on the other side of the Channel.

At the meetings of the Committee of Recommendations, the following Committees of the Association with grants of money were reappointed:—

Synopsis of Grants of Money appropriated to Scientific Purposes by the General Committee at the Liverpool Meeting, September, 1896. *The names of the Members entitled to call on the General Treasurer for the respective Grants are prefixed.*

Mathematics and Physics.

*Foster, Prof. Carey.—Electrical Standards (and unexpended balance)	£5
*Symons, Mr. G. J.—Photographs of Meteorological Phenomena	10
*Rayleigh, Lord.—Mathematical Tables	25
*Symons, Mr. G. J.—Seismological Observations ...	100
*Atkinson, Dr. E.—Abstracts of Physical Papers ...	100
*Harley, Rev. R.—Calculation of certain Integrals (partly renewed)	20
*Stokes, Sir G. G.—Solar Radiation	10
*Shaw, Mr. W. N.—Electrolysis and Electro-Chemistry...	50

Chemistry.	
*Roscoe, Sir H. E.—Wave-length Tables of the Spectra of the Elements	£10
*Reynolds, Prof. J. Emerson.—Electrolytic Quantitative Analysis	10
*Bell, Sir I. Lowthian.—Chemical Constituents of Coal	10
*Tilden, Prof. W. A.—Isomeric Naphthaline Derivatives	50
Geology.	
*Hull, Prof. E.—Erratic Blocks	10
*Bonney, Prof. T. G.—Investigation of a Coral Reef by Boring and Sounding (renewed)	40
*Seeley, Prof. H. G.—Examination of Locality where the Cetiosaurus in the Oxford Museum was found (unexpended balance in hand)	
Flower, Sir W. H.—Fauna of Singapore Caves (unexpended balance)	40
*Geikie, Prof. J.—Photographs of Geological Interest	15
Dawkins, Prof. W. Boyd.—Remains of the Irish Elk in the Isle of Man	15
*Marr, Mr. J. E.—Life Zones in British Carboniferous Rocks	15
Zoology.	
*Herdman, Prof.—Table at the Zoological Station, Naples	100
*Bourne, Mr. G. C.—Table at the Biological Laboratory, Plymouth	40
Flower, Sir W. H.—Zoological Bibliography and Publication	5
Flower, Sir W. H.—Index Generum et Specierum	100
Sclater, Dr. P. L.—Zoology and Botany of the West India Islands	40
Newton, Prof.—To Work out Details of Observations on the Migration of Birds	40
Geography.	
*Ravenstein, Mr. E. G.—Climatology of Tropical Africa	20
Economic Science and Statistics.	
——— State Monopolies in other Countries	15
Price, Mr. L. L.—Future Dealings in Raw Produce	10
Mechanical Science.	
*Preece, Mr. W. H.—Small Screw Gauge	10
Anthropology.	
*Tylor, Prof. E. B.—North-Western Tribes of Canada	75
*Munro, Dr. R.—Lake Village of Glastonbury	30
*Brabrook, Mr. E. W.—Ethnographical Survey (renewed)	40
*Galton, Sir Douglas.—Mental and Physical Condition of Children	10
*Hartland, Mr. E. S.—Linguistic and Anthropological Characteristics of the North Dravidians	5
Evans, Mr. A. J.—Silchester Excavation	20
Physiology.	
Gaskell, Dr.—Investigations of Changes in Active Nerve Cells and their Peripheral Extensions	190
*McKendrick, Prof. J. G.—Physiological Applications of the Phonograph	15
*Herdman, Prof. W. A.—Oysters under normal and abnormal environments	30
Schäfer, Prof.—Physiological Effects of Peptone and its Precursors	20
Botany.	
Farmer, Prof. J. B.—Fertilisation in Phæophyceæ	20
Corresponding Societies.	
*Meldola, Prof. R.—Preparation of Report	25
	£1355

* Re-appointed.

At the final meeting, held on Wednesday, the usual votes of thanks and concluding speeches were made, and the general impression was expressed that the success of the meeting was characterised by the magnificence of the meeting-rooms, the hospitality of the people of Liverpool, and the general liveliness of the proceedings. The British Association certainly seems, from the evidence at this, its latest meeting, to be very full of life and vigour.

W. A. HERDMAN.

SECTION C.

GEOLOGY.

OPENING ADDRESS BY J. E. MARR, M.A., F.R.S., SEC. G.S., PRESIDENT OF THE SECTION.

THE feelings of one who, being but little versed in the economic applications of his science, is called upon to address a meeting of the Association held in a large industrial centre, might, under ordinary circumstances, be of no very pleasant character; but I take courage when I remember that those connected with my native county, in which we are now gathered, have taken prominent part in advancing branches of our science which are not directly concerned with industrial affairs. I am reminded, for instance, that one amongst you, himself a busy professional man, has in his book on "The Origin of Mountain Ranges" given to the world a theoretical work of the highest value; that, on the opposite side of the county, those who are responsible for the formation and management of that excellent educational institution, the Ancoats Museum, have wisely recognised the value of some knowledge of geology as a means of quickening our appreciation of the beauties of nature; and that one who has done solid service to geology by his teachings, who has kept before us the relationship of our science to that which is beautiful—I refer to the distinguished author of "Modern Painters"—has chosen the northern part of the county for his home, and has illustrated his teaching afresh by reference to the rocks of the lovely district around him. Nor can I help referring to one who has recently passed away—the late Sir Joseph Prestwich—the last link between the pioneers of our science and the geologists of the present day, who, though born in London, was of Lancashire family, and whom we may surely therefore claim as one of Lancashire's worthies. With these evidences of the catholicity of taste on the part of geologists connected with the county, I feel free to choose my own subject for this address, and, my time being occupied to a large extent with academic work, I may be pardoned for treating that subject in academic fashion. As I have paid considerable attention to the branch of the science which bears the somewhat uncouth designation of stratigraphical geology, I propose to take the present state of our knowledge of this branch as my theme.

Of the four great divisions of geology, petrology may be claimed as being largely of German origin, the great impetus to its study having been given by Werner and his teachings. Palæontology may be as justly claimed by the French nation, Cuvier having been to so great an extent responsible for placing it upon a scientific basis. Physical geology we may partly regard as our own, the principles laid down by Hutton and supported by Playfair having received illustration from a host of British writers, amongst whom may be mentioned Jukes, Ramsay, and the brothers Geikie; but the grand principles of physical geology have been so largely illustrated by the magnificent and simple features displayed on the other side of the Atlantic, that we may well refer to our American brethren as leaders in this branch of study. The fourth branch, stratigraphical geology, is essentially British as regards origin, and, as every one is aware, its scientific principles were established by William Smith, who was not only the father of English geology, but of stratigraphical geology in general.

Few will deny that stratigraphical geology is the highest branch of the science, for, as has been well said, it "gathers up the sum of all that is made known by the other departments of the science, and makes it subservient to the interpretation of the geological history of the earth." The object of the stratigraphical geologist is to obtain information concerning all physical, climatic, and biological events which have occurred during each period of the past, and to arrange them in chronological order, so as to write a connected history of the earth. If all of this information were at our disposal, we could write a complete earth-history, and the task of the geologist would be ended. As it is, we have barely crossed the threshold of discovery, and the "imperfection of the geological record," like the "glorious uncertainty" of our national game, gives geology one of its great charms. Before passing on to consider more particularly the present state of the subject of our study, a few remarks upon this imperfection of the geological record may not be out of place, seeing that the term has been used by so many modern writers, and its exact signification occasionally misunderstood. The imperfection of the palæontological record is usually understood by the term when used, and it will be considered here as an illustration of the incompleteness of our

knowledge of earth-history; but it must be remembered that the imperfection of the physical record is equally striking, as will be insisted on more fully in the sequel.

Specially prominent amongst the points upon which we are ignorant stands the nature of the Precambrian faunas. The extraordinary complexity of the earliest known Cambrian fauna has long been a matter for surprise, and the recent discoveries in connection with the *Olenellus* fauna do not diminish the feeling.[1] After commenting upon the varied nature of the earliest known fauna, the late Prof. Huxley, in his Address to the Geological Society in 1862, stated that "any admissible hypothesis of progressive modification must be compatible with persistence without progression, through indefinite periods. . . . Should such an hypothesis eventually be proved to be true, . . . the conclusion will inevitably present itself, that the Palæozoic, Mesozoic, and Cainozoic faunæ and floræ, taken together, bear somewhat the same proportion to the whole series of living beings which have occupied this globe, as the existing fauna and flora do to them." Whether or not this estimate is correct, all geologists will agree that a vast period of time must have elapsed before the Cambrian period, and yet our ignorance of faunas existing prior to the time when the *Olenellus* fauna occupied the Cambrian seas is almost complete. True, many Precambrian fossils have been described at various times, but, in the opinion of many competent judges, the organic nature of each one of these requires confirmation. I need not, however, enlarge upon this matter, for I am glad to say we have amongst us a geologist who will at a later stage read a paper before this Section upon the subject of Precambrian fossils, and there is no one better able, owing to his intimate acquaintance with the actual relics, to present fairly and impartially the arguments which have been advanced in favour of the organic origin of the objects which have been appealed to as evidences of organisms of Precambrian age than our revered co-worker from Canada, Sir J. William Dawson. We may look forward with confidence to the future discovery of many faunas older than those of which we now possess certain knowledge, but until these are discovered, the palæontological record must be admitted to be in a remarkably incomplete condition. In the meantime, a study of the recent advance of our knowledge of early life is significant of the mode in which still earlier faunas will probably be brought to light. In 1845, Dr. E. Emmons described a fossil, now known to be an *Olenellus*, though at that time the earliest fauna was supposed to be one containing a much later group of organisms, and it was not until Nathorst and Brögger established the position of the *Olenellus* zone that the existence of a fauna earlier than that of which *Paradoxides* was a member was admitted: and, indeed, the *Paradoxides* fauna itself was proved to be earlier than that containing *Olenus*, long after these two genera had been made familiar to palæontologists, the Swedish palæontologist, Augelin, having referred the *Paradoxides* fauna to a period earlier than that of the one with *Olenus*. It is quite possible, therefore, that fossils are actually preserved in our museums at the present moment, which have been extracted from rocks deposited before the period of formation of the *Olenellus* beds, though their age has not been determined. The *Olenellus* horizon now furnishes us with a datum-line from which we can work backwards, and it is quite possible that the *Neobolus* beds of the Salt Range,[2] which underlie beds holding *Olenellus*, really do contain, as has been maintained, a fauna of date anterior to the formation of the *Olenellus* beds; and the same may be the case with the beds containing the *Protolenus* fauna in Canada,[3] for this fauna is very different from any known in the *Olenellus* beds, or at a higher horizon, though Mr. G. F. Matthew, to whom geologists owe a great debt for his admirable descriptions of the early fossils of the Canadian rocks, speaks very cautiously of the age of the beds containing *Protolenus* and its associates. Notwithstanding our ignorance of Precambrian faunas, valuable work has recently been done in proving the existence of important groups of stratified rocks deposited previously to the formation of the beds containing the earliest known Cambrian fossils; I may refer especially to the proofs of the Precambrian age of the Torridon sandstone of north-west Scotland, lately furnished by the officers of the Geological Survey, and their discovery that the maximum thickness of these strata is over 10,000 feet.[1] Amongst the sediments of this important system, more than one fauna may be discovered, even if most of the strata were accumulated with rapidity, and all geologists must hope that the officers of the Survey—who, following Nicol, Lapworth, and others, have done so much to elucidate the geological structure of the Scottish Highlands—may obtain the legitimate reward of their labours, and definitely prove the occurrence of rich faunas of Precambrian age in the rocks of that region.

But, although we may look forward hopefully to the time when we may lessen the imperfection of the records of early life upon the globe, even the most hopeful cannot expect that record to be rendered perfect, or that it will make any near approach to perfection. The posterior segments of the remarkable trilobite *Mesonacis vermontana* are of a much more delicate character than the anterior ones, and the resemblance of the spine on the fifteenth "body-segment" of this species to the terminal spine of *Olenellus* proper, suggests that in the latter sub-genus posterior segments of a purely membranous character may have existed, devoid of hard parts. If this be so, the entire outer covering of the trilobites, at a period not very remote from the end of Precambrian times, may have been membranous, and the same thing may have occurred with the structures analogous to the hard parts of organisms of other groups. Indeed, with our present views as to development, we can scarcely suppose that organisms acquired hard parts at a very early period of their existence, and fauna after fauna may have occupied the globe, and disappeared, leaving no trace of its existence, in which case we are not likely ever to obtain definite knowledge of the characters of our earliest faunas, and the biologist must not look to the geologist for direct information concerning the dawn of life upon the earth.

Proceeding now to a consideration of the faunas of the rocks formed after Precambrian times, a rough test of the imperfection of the record may be made by examining the gaps which occur in the vertical distribution of forms of life. If our knowledge of ancient faunas were very incomplete, we ought to meet with many cases of recurrence of forms after their apparent disappearance from intervening strata of considerable thickness, and many such cases have actually been described by that eminent palæontologist, M. Barrande, amongst the Palæozoic rocks of Bohemia, though even these are gradually being reduced in number owing to recent discoveries; indeed, in the case of the marine faunas, marked cases of recurrence are comparatively rare, and the occurrence of each form is generally fairly unbroken from its first appearance to its final extinction, thus showing that the imperfection of the record is by no means so marked as might be supposed. Fresh-water and terrestrial forms naturally furnish a large percentage of cases of recurrence, owing to the comparative rarity with which deposits containing such organisms are preserved amongst the strata.

A brief consideration of the main reasons for the present imperfection of our knowledge of the faunas of rocks formed subsequently to Precambrian times may be useful, and suggestive of lines along which future work may be carried out. That detailed work in tracts of country which are yet unexplored, or have been but imperfectly examined by the geologist, will add largely to our stock of information, needs only to be mentioned; the probable importance of work of this kind in the future may be inferred from a consideration of the great increase of our knowledge of the Permo-Carboniferous faunas, as the result of recent labours in remote regions. It is specially desirable that the ancient faunas and floras of tropical regions should be more fully made known, as a study of these will probably throw considerable light upon the influence of climate upon the geographical distribution of organisms in past times. The old floras and faunas of Arctic regions are becoming fairly well known, thanks to the zeal with which the Arctic regions have been explored. But, confining our attention to the geology of our own country, much remains to be done even here, and local observers especially have opportunities of adding largely to our stock of knowledge, a task they have performed so well in the past. To give examples of the value of such work, our knowledge of the fauna of the Cambrian rocks of Britain is largely due to the present President of the Geological Society, when resident at St. David's, whilst

1 Dr. C. D. Walcott, in his monograph on "The Fauna of the Lower Cambrian or Olenellus Zone" (Washington 1890), records the following great groups as represented in the Olenellus beds of America:—Spongiæ, Hydrozoa, Actinozoa, Echinodermata, Annelida? (trails, burrows, and tracks), Brachiopoda, Lamellibranchiata, Gasteropoda, Pteropoda, Crustacea, and Trilobita. Others are known as occurring in beds of the same age in the Old World.

2 See F. Noetling, "On the Cambrian Formation of the Eastern Salt Range." *Records Geol. Survey, India*, vol. xxvii. p. 71.

3 G. F. Matthew, "The Protolenus Fauna." *Trans. New York Acad. of Science*, 1895, vol. xiv. p. 101.

1 Sir A. Geikie, "Annual Report of the Geological Survey [United Kingdom] . . . for the year ending December 31, 1893." (London, 1894.)

the magnificent fauna of the Wenlock limestone would have been far less perfectly known than it is, if it were not for the collections of men like the late Colonel Fletcher and the late Dr. Grindrod. Again, the existence of the rich fauna of the Cambridge Greensand would have been unsuspected had not the bed known by that name been worked for the phosphatic nodules which it contains.

It is very desirable that large collections of varieties of species should be made, for in this matter the record is very imperfect. There has been, and, I fear, is still, a tendency to reject specimens when their characters do not conform with those given in specific descriptions, and thus much valuable material is lost. Local observers should be specially careful to search for varieties, which may be very abundant in places where the conditions were favourable for their production, though rare or unknown elsewhere. Thus, I find the late Mr. W. Keeping remarking that "it is noteworthy that at Upware, and indeed all other places known to me, the species of *Brachiopoda* [of the *Neocomian* beds] maintain much more distinctness and isolation from one another than at Brickhill."[1] The latter place appears to be one where conditions were exceptionally favourable in *Neocomian* times for the production of intermediate forms.

A mere knowledge of varieties is, however, of no great use to the collector without a general acquaintance with the morphology of the organisms whose remains he extracts from the earth's strata, and one who has this can do signal service to the science. It is specially important that local observers should be willing to devote themselves to the study of particular groups of organisms, and to collect large suites of specimens of the group they have chosen for study. With a group like the graptolites, for instance, the specimens which are apparently best preserved are often of little value from a morphological point of view, and fragments frequently furnish more information than more complete specimens. These fragments seldom find their way to our museums, and accordingly we may examine a large suite of graptolites in those museums without finding any examples showing particular structures of importance, such as the sac-like bodies carried by many of these creatures. As an illustration of the value of work done by one who has made a special study of a particular group of organisms, I may refer to the remarkable success achieved by the late Mr. Norman Glass in developing the calcareous supports of the brachial processes of Brachiopods. Work of this character will greatly reduce the imperfection of the record from the biologists' point of view.

The importance of detailed work leads one to comment upon the general methods of research which have been largely adopted in the case of the stratified rocks. The principle that strata are identifiable by their included organisms is the basis of modern work, as it was of that which was achieved by the father of English Geology, and the identification of strata in this manner has of recent years been carried out in very great detail, notwithstanding the attempt on the part of some well-known writers to show that correlation of strata in great detail is impossible. The objection to this detailed work is mainly founded upon the fact that it must take time for an organism or group of organisms to migrate from one area to another, and therefore it was stated that they cannot have lived contemporaneously in two remote areas. But the force of this objection is practically done away with if it can be shown that the time taken for migration is exceedingly short as compared with the time of duration of an organism or group of organisms upon the earth, and this has been shown in the only possible way—namely, by accumulating a very great amount of evidence as the result of observation. The eminent writers referred to above, who were not trained geologists, never properly grasped the vast periods of time which must have elapsed during the occurrence of the events which it is the geologist's province to study. An historian would speak of events which began at noon on a certain day and ended at midnight at the close of that day as contemporaneous with events which commenced and ended five minutes later, and this is quite on a par with what the geologist does when correlating strata. Nevertheless, there are many people who still view the task of correlating minute subdivisions of stratified systems with one another, with a certain amount of suspicion, if not with positive antipathy; but the work must be done for all that. Brilliant generalisations are attractive as well as valuable, but the steady accumulation of facts is as necessary for the advancement of the science as it was in the days when the Geological Society was founded, and its members applied themselves "to multiply and record observations, and patiently to await the result at some future period." I have already suggested a resemblance between geology and cricket, and I may be permitted to point out that just as in the game the free-hitter wins the applause, though the patient "stone-waller" often wins the match, so, in the science, the man apt at brilliant generalisations gains the approval of the general public, but the patient recorder of apparently insignificant details adds matter of permanent value to the stores of our knowledge. In the case of stratigraphical geology, if we were compelled to be content with correlation of systems only, and were unable to ascertain which of the smaller series and stages were contemporaneous, but could only speak of these as "homotaxial," we should be in much the same position as the would-be antiquary who was content to consider objects fashioned by the Romans as contemporaneous with those of mediæval times. Under such circumstances geology would indeed be an uncertain science, and we should labour in the field, knowing that a satisfactory earth-history would never be written. Let us hope that a brighter future is in store for us, and let me urge my countrymen to continue to study the minute subdivisions of the strata, lest they be left behind by the geologists of other countries, to whom the necessity for this kind of study is apparent, and who are carrying it on with great success.

The value of detailed work on the part of the stratigraphical geologist is best grasped if we consider the recent advance that has been made in our science owing to the more or less exhaustive survey of the strata of various areas, and the application of the results obtained to the elucidation of earth's history. A review of this nature will enable us not only to see what has been done, but also to detect lines of inquiry which it will be useful to pursue in the future; but it is obvious that the subject is so wide that little more can be attempted than to touch lightly upon some of the more prominent questions. A work might well be written treating of the matters which I propose to notice. We have all read our "Principles of Geology," or "The Modern Changes of the Earth and its Inhabitants considered as illustrative of Geology," to quote the alternative title; some day we may have a book written about the ancient changes of the earth and its inhabitants considered as illustrative of geography.

Commencing with a glance at the light thrown on inorganic changes by a detailed examination of the strata, I may briefly allude to advances which have recently been made in the study of denudation. The minor faults, which can only be detected when the small subdivisions of rock-groups are followed out carefully on the ground, have been shown to be of great importance in defining the direction in which the agents of denudation have operated, as demonstrated by Prof. W. C. Brögger, for instance, in the case of the Christiania Fjord (*Nyt. Mag. for Naturvidensk.*, vol. xxx. (1886), p. 79); and I have recently endeavoured to prove that certain valleys in the English Lake District have been determined by shattered belts of country, the existence of which is shown by following thin bands of strata along their outcrop. The importance of the study of the strata in connection with the genesis and subsequent changes of river-systems is admirably brought out in Prof. W. M. Davis's paper on "The Development of certain English Rivers (*Geograph. Journ.*, vol. v. (1895) p. 127), a paper which should be read by all physical geologists; it is, indeed, a starting-point of kindred work which remains especially for local observers to accomplish. Study of this kind not only adds to our knowledge of the work of geological agencies, but helps to diminish the imperfection of the record, for the nature of river-systems, when rightly understood, enables us to detect the former presence of deposits over areas from which they have long since been removed by denudation.

An intimate acquaintance with the lithological characters of the strata of a district affords valuable information in connection with the subject of glacial denudation. The direction of glacial transport over the British Isles has been largely inferred from a study of the distribution of boulders of igneous rock, whilst those of sedimentary rock have been less carefully observed. The importance of the latter is well shown by the work which has been done in Northern Europe in tracing the Scandinavian boulders to their sources, a task which could not have been performed successfully if the Scandinavian strata had not been

[1] W. Keeping, Sedgwick Essay: "The Fossils and Palæontological Affinities of the Neocomian Deposits of Upware and Brickhill." (Cambridge, 1883.)

studied in great detail.[1] I shall presently have more to say with regard to work connected with the lithological characters of the sediments. Whilst mentioning glacial denudation, let me allude to a piece of work which should be done in great detail, though it is not, strictly speaking, connected with stratigraphy, namely, the mapping of the rocks around asserted "rock-basins." I can find no actual proof of the occurrence of such basins in Britain, and it is very desirable that the solid rocks and the drift should be carefully inserted on large-scale maps, not only all around the shores of several lakes, but also between the lakes and the sea, in order to ascertain whether the lakes are really held in rock-basins. Until this work is done, however probable the occurrence of rock-basins in Britain may be considered to be, their actual existence cannot be expected to be proved.

When referring to the subject of denudation, mention was made a moment ago of the study of the lithological character of the sediments. Admirable work in this direction was carried out years ago by one who may be said to have largely changed the direction of advance of geology in this country owing to his researches "On the Microscopical Structure of Crystals, indicating the Origin of Minerals and Rocks." I refer, of course, to Dr. H. C. Sorby. But since our attention has been so largely directed to petrology, the study of the igneous and metamorphic rocks has been most zealously pursued, whilst that of the sediments has been singularly little heeded, with few exceptions, prominent amongst which is the work of Mr. Maynard Hutchings, the results of which have been recently published in the *Geological Magazine*, though we must all hope that the details which have hitherto been supplied to us, valuable as they are, are only a foretaste of what is to follow from the pen of this able observer. Descriptions of the lithological changes which occur in a vertical series of sediments, as well as of those which are observed when any particular band is traced laterally, will no doubt throw light upon a number of interesting questions.

Careful work amongst the ancient sediments, especially those which are of organic origin, has strikingly illustrated the general identity of characters, and therefore of methods of formation, of deposits laid down on the sea-floors of past times and those which are at present in course of construction. Globigerine-oozes have been detected at various horizons and in many countries. Prof. H. Alleyne Nicholson (Nicholson and Lydekker, "Manual of Palæontology," chap. ii.) has described a pteropod-ooze of Devonian age in the Hamilton Limestone of Canada, which is largely composed of the tests of *Styliola*: and to Dr. G. J. Hinde we owe the discovery of a large number of radiolarian cherts of Palæozoic and Neozoic ages in various parts of the globe. The extreme thinness of many argillaceous deposits, which are represented elsewhere by hundreds of feet of strata, suggests that some of them, at any rate, may be analogous to the deep-sea clays of modern oceans, though in the case of deposits of this nature we must depend to a large extent upon negative evidence. The uniformity of character of thin marine deposits over wide areas is in itself evidence of their formation at some distance from the land; but although the proofs of origin of ancient sediments far from coast-lines may be looked upon as permanently established, the evidence for their deposition at great depths below the ocean's surface might be advantageously increased in the case of many of them. The fairly modern sediments, containing genera which are still in existence, are more likely to furnish satisfactory proofs of a deep-sea origin than are more ancient deposits. Thus the existence of *Archæopneustes* and *Cystechinus* in the oceanic series of Barbadoes, as described by Dr. Gregory, furnishes strong proofs of the deep-sea character of the deposits, whilst the only actual argument in favour of the deep-sea character of certain Palæozoic sediments has been put forward by Prof. Suess, who notes the similarity of certain structures of creatures in ancient rocks to those possessed by modern deep-sea crustacea, especially the co-existence of trilobites which are blind with those which have enormously developed eyes.

A question which has been very prominently brought to the fore in recent years is that of the mode of formation of certain coral-reefs. The theory of Charles Darwin, lately so widely accepted as an explanation of the mode of formation of barrier-reefs and atolls, has been, as is well known, criticised by Dr. Murray, with the result that a large number of valuable observations have been recently made on modern reefs, especially by biologists, as a contribution to the study of reef formation. Nor have geologists been inactive. Dr. E. Mojsisovics and Prof. Dupont, to mention two prominent observers, have described knoll-like masses of limestone more or less analogous, as regards structure, to modern coral-reefs. They consider that these have been formed by corals, and indeed Dupont maintains that the atoll-shape is still recognisable in ancient Devonian coral-reefs in Belgium.[1] I would observe that all cases of "knoll-reefs" of this character have been described in districts which furnish proofs of having been subjected to considerable orogenic disturbance, subsequent to the formation of the rocks composing the knoll-shaped masses, whilst in areas which have not been affected by violent earth-foldings, the reef-building corals, so far as I have been able to ascertain, give rise to sheet-like masses, such as should be produced according to Dr. Murray's theory. I would mention especially the reefs of the Corallian Rocks of England, and also some admirable examples seen amongst the Carboniferous Limestone strata of the great western escarpment of the Pennine chain which faces the Eden valley in the neighbourhood of Melmerby in Cumberland. Considering the number of dissected coral-reefs which exist amongst the strata of the earth's crust, and the striking way in which their structure is often displayed, it is rather remarkable that comparatively little attention has been paid to them by geologists in general, when the subject has been so prominently brought before the scientific world, for we must surely admit that we are much more likely to gain important information, shedding light upon the methods of reef-formation, by a study of such dissected reefs, than by making a few bore-holes on some special coral island. I would specially recommend geologists to make a detailed study of the British coral-reefs of Silurian, Devonian, Carboniferous, and Jurassic ages.

Turning now to organic deposits of vegetable origin, we must, as the result of detailed work, be prepared to admit the inapplicability of any one theory of the formation of coal seams. The "growth-in-place" theory may be considered fairly well established for some coals, such as the spore-coals, whilst the "drift" theory furnishes an equally satisfactory explanation of the formation of cannel-coal. It is now clear that the application of the general term *coal* to a number of materials of diverse nature, and probably of diverse origin, was largely responsible for the dragging-out of a controversy, in which the champions of either side endeavoured to explain the origin of all coal in one particular way.

The stratigraphical geologist, attempting to restore the physical geography of former periods, naturally pays much attention to the positions of ancient coast-lines; indeed, all teachers find it impossible to give an intelligible account of the stratified rocks without some reference to the distribution of land and sea at the time of their formation. The general position of land-masses at various times has been ascertained in several parts of the world, but much more information must be gathered together before our restorations of ancient sea-margins approximate to the truth. The carboniferous rocks of Britain have been specially studied with reference to the distribution of land and water during the period of their accumulation, and yet we find that owing to the erroneous identification of certain rocks of Devonshire as grits or sandstones, which Dr. Hinde has shown to be radiolarian cherts, land was supposed to lie at no great distance south of this region in Lower Carboniferous times, whereas the probabilities are in favour of the existence of an open ocean at a considerable distance from any land in that direction. This case furnishes us with an excellent warning against generalisation upon insufficient data.

As a result of detailed study of the strata, the effects of earth-movements have been largely made known to us, especially of those comparatively local disturbances spoken of as orogenic which are mainly connected with mountain-building, whilst information concerning the more widely spread epeirogenic movements is also furnished by a study of the stratified rocks. The structure of the Alps, of the North-West Highlands of Scotland, and of the uplifted tracts of North America is now familiar to geologists, whilst the study of comparatively recent sediments has proved the existence of widespread and extensive movements in times which are geologically modern; for instance,

[1] It is desirable that the boulders of sedimentary rock imbedded in the drifts of East Anglia should be carefully examined and fossils collected from them. The calcareous strata associated with the Alum Shales of Scandinavia and the strata of the Orthoceras-Limestone of that region may be expected to be represented amongst the boulders.

[1] Similar knoll-like masses have been described in this country by Mr. R. H. Tiddeman, as occurring in the Craven district of Yorkshire, but he does not attribute their formation to coral growth to any great extent.

the deep-water deposits of late Tertiary age found in the West Indies indicate the occurrence of considerable uplift in that region. But a great amount of work yet remains to be done in this connection, especially concerning horizontal distortion of masses of the earth's crust, owing to more rapid horizontal advance of one portion than of another, during periods of movement. Not until we gather together a large amount of information derived from actual inspection of the rocks shall we be able to frame satisfactory theories of earth-movement, and in the meantime we are largely dependent upon the speculations of the physicist, often founded upon very imperfect data, on which is built an imposing superstructure of mathematical reasoning. We have been told that our continents and ocean-basins have been to a great extent permanent as regards position through long geological ages; we now reply by pointing to deep-sea sediments of nearly all geological periods, which have been uplifted from the ocean-abysses to form portions of our continents; and as the result of study of the distribution of fossil organisms, we can point almost as confidently to the sites of old continents now sunk down into the ocean depths. It seems clear that our knowledge of the causes of earth-movements is still in its infancy, and that we must be content to wait awhile, until we have further information at our disposal.

Recent work has proved the intimate connection betwixt earth-movement and the emission and intrusion of igneous rocks, and the study of igneous rocks has advanced beyond the petrographical stage; the rocks are now made to contribute their share towards the history of different geological periods. The part which volcanic action has played in the actual formation of the earth's crust is well exemplified in Sir Archibald Geikie's Presidential Addresses to the Geological Society, wherein he treats of the former volcanic history of the British Isles. (*Quart. Journ. Geol. Soc.*, vols. xlvii. and xlviii.) The way in which extruded material contributes to the formation of sedimentary masses has, perhaps, not been fully grasped by many writers, who frequently seem to assume that deposition is a measure of denudation, and *vice versâ*, whereas deposition is only a measure of denudation, and of the material which has been ejected in a fragmental condition from the earth's interior, which in some places forms a very considerable percentage of the total amount of sediment.

The intruded rocks also throw much light on past earth-history, and I cannot give a better illustration of the valuable information which they may furnish to the stratigraphical geologist when rightly studied, than by referring to the excellent and suggestive work by my colleague, Mr. Alfred Harker, on the Bala Volcanic Rocks of Carnarvonshire. (*Sedgwick Essay* for 1888: Camb. Univ. Press, 1889.)

Perhaps the most striking instance of the effect which detailed stratigraphical work has produced on geological thought is supplied by the study of the crystalline schists. Our knowledge of the great bulk of the rocks which enter into the formation of a schistose complex is not very great, but the mode of production of many of them is now well known, and the crude speculations of some of the early geologists are now making way for theories founded on careful and minute observations in the field as well as in the laboratory. Recent work amongst the crystalline schists shows, furthermore, how careful we should be not to assume that because we have got at the truth, we have therefore ascertained the whole truth. We all remember how potent a factor dynamic metamorphism was supposed to be, owing to discoveries made in the greatly disturbed rocks of Scotland and Switzerland; and the action of heat was almost ignored by some writers, except as a minor factor, in the production of metamorphic change. The latest studies amongst the foliated rocks tend to show that heat does play a most important part in the manufacture of schists. The detailed work of Mr. George Barrow, in North-East Forfarshire (*Quart. Journ. Geol. Soc.*, vol. xlix. (1893) p. 330) has already thrown a flood of light upon the origin of certain schists, and their connection with igneous rocks, and geologists will look forward with eagerness to further studies of the puzzling Highland rocks by this keen observer.

The subject of former climatic conditions is one in which the geologist has very largely depended upon followers of other branches of science for light, and yet it is one peculiarly within the domain of the stratigraphical geologist; and information which has already been furnished concerning former climatic conditions, as the result of careful study of the strata, is probably only an earnest of what is to follow when the specialist in climatology pays attention to the records of the rocks, and avoids the theories elaborated in the student's sanctum. The recognition of an Ice Age in Pleistocene times at once proved the fallacy of the supposition that there has been a gradual fall in temperature throughout geological ages without any subsequent rise, and accordingly most theories which have been put forward to account for former climatic change have been advanced with special reference to the Glacial period or periods, although there are many other interesting matters connected with climate with which the geologist has to deal. Nevertheless, the occurrence of glacial periods is a matter of very great interest, and one which has deservedly received much attention, though the extremely plausible hypothesis of Croll, and the clear manner in which it has been presented to general readers, tended to throw other views into the shade, until quite recently, when this hypothesis has been controverted from the point of view of the physicist. In the meantime considerable advance has been made in our actual knowledge, and this year, probably for the first time, and as the result of the masterly *résumé* of Prof. Edgworth David ("Evidences of Glacial Action in Australia in Permo-Carboniferous Time," *Quart. Journ. Geol. Soc*, vol. lii. p. 289), the bulk of British geologists are prepared to admit that there has been more than one glacial period, and that the evidence of glacial conditions in the southern hemisphere in Permo-Carboniferous times is established. Croll's hypothesis of course requires the recurrence of glacial periods, but leaving out of account arguments not of a geological character, which have been advanced against this hypothesis, the objection raised by Messrs. Gray and Kendall ("The Cause of an Ice Age," *Brit. Assoc. Rep.* (1892), p. 708), that in the case of the Pleistocene Ice Age "the cold conditions came on with extreme slowness, the refrigerations being progressive from the Eocene period to the climax," seems to me to be a fatal one. At the same time, rather than asking with the above writers "the aid of astronomers and physicists in the solution of" this problem, I would direct the attention of stratigraphical geologists to it, believing that, by steady accumulation of facts, they are more likely than any one else to furnish the true clue to the solution of the glacial problem.

I have elsewhere called attention to marked changes in the faunas of the sedimentary rocks when passing from lower to higher levels, without the evidence of any apparent physical break, or any apparent change in the physical conditions, so far as can be judged from the lithological characters of the strata, and have suggested that such sudden faunistic variations may be due to climate. I refer to the matter as one which may well occupy the attention of local observers.

One of the most interesting points connected with climatic conditions is that of the former general lateral distribution of organisms, and its dependence upon the distribution of climatic zones. The well-known work of the late Dr. Neumayr ("Ueber klimatische Zonen wahrend der Jura-und Kreidezeit," *Denkschr. der math.-naturwissen. Classe der k. k. Akad. der Wissenschaften*, vol. xlvii. Vienna, 1883) has, in the opinion of many geologists, established the existence of climatic zones whose boundaries ran practically parallel with the equator in Jurassic and Cretaceous times, and the possible existence of similar climatic zones in Palæozoic times has been elsewhere suggested; but it is very desirable that much more work should be done upon this subject, and it can only be carried out by paying close attention to the vertical and lateral distribution of organisms in the stratified rocks.

So far we have chiefly considered the importance of stratigraphical geology in connection with the inorganic side of nature. We now come to the bearing of detailed stratigraphical work upon questions concerning the life of the globe, and here the evidence furnished by the geologist particularly appeals to the general educated public as well as to students of other sciences.

Attention has just been directed to the probable importance of former climatic changes in determining the distribution of organisms, but the whole subject of the geographical distribution of organisms during former geological periods, though it has already received a considerable amount of attention, will doubtless have much further light thrown upon it as the result of careful observations carried out amongst the stratified rocks.

So long ago as 1853, Pictet laid it down as a palæontological law that "the geographical distribution of species found in the strata was more extended than the range of species of existing faunas." One would naturally expect that at a time when the diversity of animal organisation was not so great as it now is, the species, having fewer enemies with which to cope, and on the whole not too complex organisations to be affected by out-

ward circumstances, would spread further laterally than they now do; but as we know that in earliest Cambrian times the diversity of organisation was very considerable, it is doubtful whether any appreciable difference would be exerted upon lateral distribution then and now, owing to this cause. At the time at which Pictet wrote, the rich fauna of the deeper parts of the oceans, with its many widely distributed forms of life, was unknown, and the range in space of early organisms must have then struck every one who thought upon the subject as being greater than that of the shallow-water organisms of existing seas, which were alone known. It is by no means clear, however, with our present knowledge, that Pictet's supposed law holds good, and it will require a considerable amount of work before it can be shown to be even apparently true. Our lists of the fossils of different areas are not sufficiently complete to allow us to generalise with safety, but a comparison of the faunas of Australia and Britain indicates a larger percentage of forms common to the two areas, as we examine higher groups of the geological column. If this indication be fully borne out by further work, it will not prove the actual truth of the law, for the apparent wider distribution of ancient forms of life might be due to the greater probability of elevation of ancient deep-sea sediments than of more modern ones which have not been subjected to so many elevatory movements. Still, if the law be apparently true, it is a matter of some importance to geologists; and I have touched upon the matter here in order once again to emphasise the possibility of correlating comparatively small thicknesses of strata in distant regions by their included organisms.

Mention of Pictet's laws, one of which states that fossil animals were constructed upon the same plan as existing ones, leads me to remark upon the frequent assumption that certain fossils are closely related to living groups, when the resemblances between the hard parts of the living and extinct forms are only of the most general character. There is a natural tendency to compare a fossil with its nearest living ally, but the comparison has probably been often pushed too far, with the result that biologists have frequently been led to look for the ancestors of one living group exclusively amongst forms of life which are closely related to those of another living group. The result of detailed work is to bring out more and more prominently the very important differences between some ancient forms and any living creature, and to throw doubts on certain comparisons; thus I find several of the well-known fossils of the Old Red Sandstone, formerly referred without hesitation to the fishes, are now doubtfully placed in that class.

The importance of detailed observation in the field is becoming every day more apparent, and the specialist who remains in his museum examining the collections amassed by the labours of others, and never notes the mode of occurrence of fossils in the strata, will perhaps soon be extinct, himself an illustration of the principle of the survival of the fittest. In the first place, such a worker can never grasp the true significance of the changes wrought on fossil relics after they have become entombed in the strata, especially amongst those rocks which have been subjected to profound earth-movements; and it is to be feared that many "species" are still retained in our fossil lists, whose supposed specific characters are due to distortion by pressure. But a point of greater importance is, that one who confines his attention to museums, cannot, unless the information supplied to him be very full, distinguish the differences between fossils which are variations from a contemporaneous dominant form, such as "sports," and those which have been termed "mutations," which existed at a later period than the forms which they resemble. The value of the latter to those who are attempting to work out phylogenies is obvious, and their nature can only be determined as the result of very laborious and accurate field-work; but such labour in such a cause is well worth performing. The student of phylogeny has had sufficient warning of the dangers which beset his path, from an inspection of the various phylogenetic trees, constructed mainly after study of existing beings only, so

> ". . . like the borealis race,
> That flit ere you can point their place,"

but recent researches amongst various groups of fossil organisms have further illustrated the danger of theorising upon insufficient data, especially suggestive being the discovery of closely similar forms which were formerly considered to be much more nearly related than now proves to be the case; thus Dr. Mojsisovics (*Abhandl. der k. k. geol. Reichsanst.*, vol. vi., 1893) has shown that Ammonites once referred to the same species are specifically distinct, though their hard parts have acquired similar structures, sometimes contemporaneously, sometimes at different times, and Mr. S. S. Buckman (*Quart. Journ. Geol. Soc.*, vol. li. p. 456, 1895) has observed the same thing, which he speaks of as "heterogenetic homœomorphy" in the case of certain brachiopods, whilst Prof. H. A. Nicholson and I (*Geol. Mag.*, December 4, 1895, vol. ii. p. 531) have given reasons for supposing that such heterogenetic homœomorphy, in the case of the graptolites, has sometimes caused the inclusion in one genus of forms which have arisen from two distinct genera. As the result of careful work, dangers of the nature here suggested will be avoided, and our chances of indicating lines of descent correctly will be much increased. It must be remembered that however plausible the lines of descent indicated by students of recent forms may be, the actual links in the chains can only be discovered by examination of the rocks, and it is greatly to be desired that more of our geologists, who have had a thorough training in the field, should receive in addition one as thorough in the zoological laboratory. Shall I be forgiven if I venture on the opinion that a certain suspicion which some of my zoological fellow countrymen have of geological methods, is due to their comparative ignorance of palæontology, and that it is as important for them to obtain some knowledge of the principles of geology as it is for the stratigraphical palæontologist to study the soft parts of creatures whose relatives he finds in the stratified rocks?

The main lines along which the organisms of some of the larger groups have been developed, have already been indicated by several palæontologists, and detailed work has been carried out in several cases. As examples, let me allude to the trilobites, of which a satisfactory natural classification was outlined by the great Barrande in those volumes of his monumental work which deal with the fossils of this order, whilst further indication of their natural inter-relationships has been furnished by Messrs. C. D. Walcott, G. F. Matthew, and others; to the graptolites, whose relationships have been largely worked out by Prof. C. Lapworth, *facile princeps* amongst students of the *Graptolitoidea*, to whom we look for a full account of the phylogeny of the group; to the brachiopods, which have been so ably treated by Dr. C. E. Beecher ("Development of the Brachiopoda," *Amer. Journ. Sci.*, ser. iii. vol. xli. (1891) p. 343, and vol. xliv. (1892) p. 133), largely from a study of recent forms, but also after careful study of those preserved in the fossil state; and to the echinids and lamellibranchs, whose history is being extensively elucidated by Dr. R. T. Jackson ("Phylogeny of the Pelecypoda," *Mem. Boston Soc. Nat. Hist.*, vol. iv. (1890) p. 277; and "Studies of Palæechinoidea," *Bull. Geol. Soc. Amer.*, vol. vii. (1896) p. 171), by methods somewhat similar to those pursued by Dr. Beecher. I might give other instances,[1] but have chosen some striking ones, four of which especially illustrate the great advances which are being made in the study of the palæontology of the invertebrates by our American brethren.

I have occupied the main part of my address with reasons for the need of conducting stratigraphical work with minute accuracy. Many of you may suppose that the necessity for working in this way is so obvious that it is a work of supererogation to insist upon it at great length; but experience has taught me that many geologists consider that close attention to details is apt to deter workers from arriving at important generalisations, in the present state of our science. A review of the past history of the science shows that William Smith, and those who followed after him, obtained their most important results by steady application to details, and subsequent generalisation, whilst the work of those who theorise on insufficient data is apt to be of little avail, though often demanding attention on account of its very daring, and because of the power of some writers to place erroneous views in an attractive light, just as

> ". . . the sun can fling
> Colours as bright on exhalations bred
> By weedy pool or pestilential swamp,
> As on the rivulet, sparkling where it runs,
> Or the pellucid lake."

[1] *E.g.* The following papers treating of the Cephalopoda:—A. Hyatt, "Genesis of the Arietidæ," Smithsonian Contributions, vol. xxvi. (1889); M. Neumayr, Jura-Studien I., "Ueber Phylloceraten," *Jahrb. der k. k. Geol. Reichsanst*, vol. xxi. (1871) p. 297; L. Würtenberger, "Studien übe die Stammesgeschichte der Ammoniten," Leipzig, 1880; S. S. Buckman, "A Monograph of the Inferior Oolite Ammonites of the British Islands, 1887 (*Monogr. Palæontographical Soc.*).

Nor is there any reason to suppose that it will be otherwise in the future, and I am not one of those who consider that the brilliant discoveries were the exclusive reward of the pioneers in our science, and that labourers of the present day must be contented with the gleanings of their harvest; on the contrary, the discoveries which await the geologist will probably be as striking as are those which he has made in the past. The onward march of science is a rhythmic movement, with now a period of steady labour, anon a more rapid advance in our knowledge. It would perhaps be going too far to say that, so far as our science is concerned, we are living in a period rather of the former than of the latter character, though no great geological discovery has recently affected human thought in the way in which it was affected by the proofs of the antiquity of man, and by the publication of "The Origin of Species." If, however, we are to some extent gathering materials, rather than drawing far-reaching conclusions from them, I believe this is largely due to the great expansion which our science has undergone in recent years. It has been said that geology is "not so much one science, as the application of all the physical sciences to the examination and description of the structure of the earth, the investigation of the agencies concerned in the production of that structure, and the history of their action"; and the application of other sciences to the elucidation of the history of our globe has been so greatly extended of recent years, that we are apt to lose sight of the fact that geology is in itself a science, and that it is the special province of the geologist to get his facts at first hand from examination of the earth. The spectroscope and the telescope tell the geologist much; but his proper instrument is the hammer, and the motto of every geologist should be that which has been adopted for the Geological Congress, *Mente et malleo.*

At the risk of being compared to a child playing with edged tools, I cannot help referring to the bearing of modern stratigraphical research on the suggested replacement of a school of uniformitarianism by one of evolution. The distinguished advocate of Evolutionism, who addressed the Geological Society in 1869 upon the modern schools of geological thought, spoke of the school of evolution as though it were midway between those of uniformitarianism and catastrophism, as indeed it is logically, though, considering the tenets of the upholders of catastrophism, as opposed to those of uniformitarianism, at the time of that address, there is no doubt that evolutionism was rather a modification of the uniformitarianism of the period than intermediate between it and catastrophism, which was then practically extinct, at any rate in Britain. One of my predecessors in this chair, speaking upon this subject, says that "the good old British ship 'Uniformity,' built by Hutton and refitted by Lyell, has won so many glorious victories in the past, and appears still to be in such excellent fighting trim, that I see no reason why she should haul down her colours, either to 'catastrophe' or 'evolution.'" It may be so; but I doubt the expediency of nailing those colours to the mast. That Lyell, in his great work, proved that the agents now in operation, working with the same activity as that which they exhibit at the present day, *might* produce the phenomena exhibited by the stratified rocks, seems to be generally admitted, but that is not the same thing as proving that they *did* so produce them. Such proof can only be acquired by that detailed examination of the strata which I have advocated in this address, and at the time that the last edition of the "Principles" appeared, our knowledge of the strata was far less complete than it has subsequently become. It appears to me that we should keep our eyes open to the possibility of many phenomena presented by rocks, even newer than the Archæan rocks, having been produced under different conditions from those now prevalent. The depths and salinity of the oceans, the heights and extent of continents, the conditions of volcanic action, and many other things may have been markedly different from what they are at present, and it is surely unphilosophical to assume conditions to have been generally similar to those of the present day, on the slender data at our disposal. Lastly, uniformitarianism, in its strictest sense, is opposed to rhythmic recurrence of events. "Rhythm is the rule with nature; she abhors uniformity more than she does a vacuum," wrote Prof. Tyndall, many years ago, and the remark is worth noting by geologists. Why have we no undoubted signs of glacial epochs amongst the strata from early Cambrian times to the Great Ice Period, except in Permo-Carboniferous times? Is there not an apparent if not a real absence of manifestation of volcanic activity over wide areas of the earth in Mesozoic times? Were not Devonian, Permo-Triassic, and Miocene times periods of mountain-building over exceptionally wide areas, whilst the intervening periods were rather marked by quiet depression and sedimentation? A study of the evidence available in connection with questions like these suggests rhythmic recurrence. Without any desire to advocate hasty departure from our present methods of research, I think it should be clearly recognised that evolution may have been an important factor in changing the conditions even of those times of which the geologist has more direct knowledge. In this, as in many other questions, it is best to preserve an open mind; indeed, I think that geologists will do well to rest satisfied without an explanation to many problems, amongst them the one just referred to; and that working hypotheses, though useful, are better retained in the manuscript notebooks of the workers than published in the *Transactions* of Learned Societies, whence they filter out into popular works, to the great delight of a sceptical public should they happen to be overthrown.

May I trespass upon your patience for one moment longer? As a teacher of geology, with many years' experience in and out of a large University, I have come to the conclusion that geology is becoming more generally recognised as a valuable instrument of education. The memory, the reasoning faculties, and the powers of observation are alike quickened. The work in the open air, which is inseparable from a right understanding of the science, keeps the body in healthy condition. But over and above these benefits, the communing with nature, often in her most impressive moods, and the insignificance of events in a man's lifetime, as compared with the ceaseless changes through the long æons which have gone before, so influence man's moral nature, that they drive out his meaner thoughts and make him "live in charity with all men."

SECTION D.

ZOOLOGY.

Opening Address by Prof. E. B. Poulton, F.R.S., President of the Section.

A very brief study of the proceedings of this Section in byegone years will show that Presidents have exercised a very wide choice in the selection of subjects. At the last meeting of the Association in this city in 1870 the Biological Section had as its President the late Prof. Rolleston, a man whose remarkable personality made a deep impression upon all who came under his influence, as I have the strongest reason for remembering, inasmuch as he was my first teacher in zoology, and I attended his lectures when but little over seventeen. His address was most characteristic, glancing over a great variety of subjects, literary as well as scientific, and abounding in quotations from several languages, living and dead. A very different style of address was that delivered by the distinguished zoologist who presided over the meeting. Prof. Huxley took as his subject "The History of the Rise and Progress of a Single Biological Doctrine."

Of these two types I selected the latter as my example, and especially desired to attempt the discussion, however inadequate, of some difficulty which confronts the zoologist at the very outset, when he begins to reason from the facts around him—a difficulty which is equally obvious and of equal moment to the highly-trained investigator and the man who is keenly interested in the results obtained by others, but cannot himself lay claim to the position and authority of a skilled observer—to the naturalist and to one who follows some other branch of knowledge, but is interested in the progress of a sister science.

Two such difficulties were alluded to by Lord Salisbury in his interesting presidential address to the British Association at Oxford in 1894, when he spoke of "two of the strongest objections to the Darwinian explanation" of evolution—viz. the theory of natural selection—as appearing "still to retain all their force." The first of these objections was the insufficiency of the time during which the earth has been in a habitable state, as calculated by Lord Kelvin and Prof. Tait, 100 million years being conceded by the former, but only 10 million by the latter. Lord Salisbury quite rightly stated that for the evolution of the organic world as we know it by the slow process of natural selection at least many hundred million years are required;

whereas, "if the mathematicians are right, the biologists cannot have what they demand. . . . The jelly-fish would have been dissipated in steam long before he had had a chance of displaying the advantageous variation which was to make him the ancestor of the human race."

The second objection was that "we cannot demonstrate the process of natural selection in detail; we cannot even, with more or less ease, imagine it." "In natural selection who is to supply the breeder's place?" "There would be nothing but mere chance to secure that the advantageously varied bridegroom at one end of the wood should meet the bride, who by a happy contingency had been advantageously varied in the same direction at the same time at the other end of the wood. It would be a mere chance if they ever knew of each other's existence—a still more unlikely chance that they should resist on both sides all temptations to a less advantageous alliance. But unless they did so the new breed would never even begin, let alone the question of its perpetuation after it had begun."

Prof. Huxley, in seconding the vote of thanks to the President, said that he could imagine that certain parts of the address might raise a very good discussion in one of the Sections, and I have little doubt that he referred to these criticisms and to this Section. When I had to face the duty of preparing this address, I could find no subjects better than those provided by Lord Salisbury.

At first the second objection seemed to offer the more attractive subject. It was clear that the theory of natural selection as held by Darwin was misconceived by the speaker, and that the criticism was ill-aimed. Darwin and Wallace, from the very first, considered that the minute differences which separate individuals were of far more importance than the large single variations which occasionally arise—Lord Salisbury's advantageously varied bride and bridegroom at opposite ends of the wood. In fact, after Fleeming Jenkins's criticisms in the *North British Review* for June 1867, Darwin abandoned these large single variations altogether. Thus he wrote in a letter to Wallace February 2, 1869): "I always thought individual differences more important; but I was blind, and thought single variations might be preserved much oftener than I now see is possible or probable. I mentioned this in my former note merely because I believed that you had come to a similar conclusion, and I like much to be in accord with you." ("Life and Letters," vol. iii.) Hence we may infer that the other great discoverer of natural selection had come to the same conclusion at an even earlier date. But this fact removes the whole point from the criticism I have just quoted. According to the Darwin-Wallace theory of natural selection, individuals sufficiently advantageously varied to become the material for a fresh advance when an advance became necessary, and at other times sufficient to maintain the ground previously gained—such individuals existed not only at the opposite ends of the wood, but were common enough in every colony within its confines. The mere fact that an individual had been able to reach the condition of a possible bride or bridegroom would count for much. Few will dispute that such individuals "have already successfully run the gauntlet of by far the greatest dangers which beset the higher animals [and, it may be added, the lower animals also]—the dangers of youth. Natural selection has already pronounced a satisfactory verdict upon the vast majority of animals which have reached maturity." (Poulton, "Colours of Animals," p. 308.)

But the criticism retains much force when applied to another theory of evolution by the selection of large and conspicuous variations, a theory which certain writers have all along sought to add to or substitute for that of Darwin. Thus Huxley from the very first considered that Darwin had burdened himself unnecessarily in rejecting *per saltum* evolution so unreservedly. (See his letter to Darwin, November 23, 1859; "Life and Letters," vol. ii.) And recently this view has been revived by Bateson's work on variation and by the writings of Francis Galton. I had at first intended to attempt a discussion of this view, together with Lord Salisbury's and other objections which may be urged against it; but the more the two were considered, the more pressing became the claims of the criticism alluded to at first—the argument that the history of our planet does not allow sufficient time for a process which all its advocates admit to be extremely slow in its operation. I select this subject because of its transcendent importance in relation to organic evolution, and because I hope to show that the naturalist has something of weight to contribute to the controversy which has been waged intermittently ever since Lord Kelvin's paper "On Geological Time"[1] appeared in 1868. It has been urged by the great worker and teacher who occupied the Presidential Chair of this Association when it last met in this city that biologists have no right to take part in this discussion. In his Anniversary Address to the Geological Society in 1869 Huxley said: "Biology takes her time from geology. . . . If the geological clock is wrong, all the naturalist will have to do is to modify his notions of the rapidity of change accordingly." This contention is obviously true as regards the time which has elapsed since the earliest fossiliferous rocks were laid down. For the duration of the three great periods we must look to the geologist; but the question as to whether the whole of organic evolution is comprised within these limits, or, if not, what proportion of it is so contained, is a question for the naturalist. The naturalist alone can tell the geologist whether his estimate is sufficient, or whether it must be multiplied by a small or by some unknown but certainly high figure, in order to account for the evolution of the earliest forms of life known in the rocks. This, I submit, is a most important contribution to the discussion.

Before proceeding further it is right to point out that obviously these arguments will have no weight with those who do not believe that evolution is a reality. But although the causes of evolution are greatly debated, it may be assumed that there is no perceptible difference of opinion as to evolution itself, and this common ground will bear the weight of all the zoological arguments we shall consider to-day.

It will be of interest to consider first how the matter presented itself to naturalists before the beginning of this controversy on the age of the habitable earth. I will content myself with quotations from three great writers on biological problems—men of extremely different types of mind, who yet agreed in their conclusions on this subject.

In the original edition of the "Origin of Species" (1859), Darwin, arguing from the presence of trilobites, Nautilus, Lingula, &c., in the earliest fossiliferous rocks, comes to the following conclusion (pages 306, 307): "Consequently, if my theory be true, it is indisputable that before the lowest Silurian stratum was deposited long periods elapsed, as long as, or probably far longer than, the whole interval from the Silurian age to the present day; and that during these vast yet quite unknown periods of time the world swarmed with living creatures."

The depth of his conviction in the validity of this conclusion is seen in the fact that the passage remains substantially the same in later editions, in which, however, Cambrian is substituted for Silurian, while the words "yet quite unknown" are omitted, as a concession, no doubt, to Lord Kelvin's calculations, which he then proceeds to discuss, admitting as possible a more rapid change in organic life, induced by more violent physical changes. (Sixth ed., 1872, p. 286.)

We know, however, that such concessions troubled him much, and that he was really giving up what his judgment still approved. Thus he wrote to Wallace on April 14, 1869: "Thomson's views of the recent age of the world have been for some time one of my sorest troubles. . . ." And again, on July 12, 1871, alluding to Mivart's criticisms, he says: "I can say nothing more about missing links than what I have said. I should rely much on pre-Silurian times; but then comes Sir W. Thomson, like an odious spectre."

Huxley's demands for time in order to account for pre-Cambrian evolution, as he conceived it, were far more extensive. Although in 1869 he bade the naturalist stand aside and take no part in the controversy, he had nevertheless spoken as a naturalist in 1862, when, at the close of another Anniversary Address to the same Society, he argued from the prevalence of persistent types "that any admissible hypothesis of progressive modification must be compatible with persistence without progression through indefinite periods"; and then maintained that "should such an hypothesis eventually be proved to be true . . . the conclusion will inevitably present itself that the Palæozoic, Mesozoic, and Cainozoic faunæ and floræ, taken together, bear somewhat the same proportion to the whole series of living beings which have occupied this globe as the existing fauna and flora do to them."

[1] *Trans. Geol. Soc.*, Glasgow, vol. iii. See also "On the Age of the Sun's Heat," *Macmillan*, March 1862: reprinted as Appendix to Thomson and Tait, "Natural Philosophy," vol. i. part 2, second edition; and "On the Secular Cooling of the Earth," Royal Society of Edinburgh, 1862.

Herbert Spencer, in his article on "Illogical Geology" in the *Universal Review* for July 1859 (reprinted in his "Essays," 1868, vol. i., pp. 324–376), uses these words: "Only the last chapter of the earth's history has come down to us. The many previous chapters, stretching back to a time immeasurably remote, have been burnt, and with them all the records of life we may presume they contained." Indeed, so brief and unimportant does Herbert Spencer consider this last chapter to have been that he is puzzled to account for "such evidences of progression as exist"; and finally concludes that they are of no significance in relation to the doctrine of evolution, but probably represent the succession of forms by which a newly upheaved land would be peopled. He argues that the earliest immigrants would be the lower forms of animal and vegetable life, and that these would be followed by an irregular succession of higher and higher forms, which "would thus simulate the succession presented by our own sedimentary series."

We see, then, what these three great writers on evolution thought on this subject: they were all convinced that the time during which the geologists concluded that the fossiliferous rocks had been formed was utterly insufficient to account for organic evolution.

Our object to-day is first to consider the objections raised by physicists against the time demanded by the geologist, and still more against its multiplication by the student of organic evolution; secondly, to inquire whether the present state of palæontological and zoological knowledge increases or diminishes the weight of the threefold opinion quoted above—an opinion formed on far more slender evidence than that which is now available. And if we find this opinion sustained, it must be considered to have a very important bearing upon the controversy.

The arguments of the physicists are three:—

First, the argument from the observed secular change in the length of the day the most important element of which is due to tidal retardation. It has been known for a very long time that the tides are slowly increasing the length of our day. Huxley explains the reason with his usual lucidity: "That this must be so is obvious, if one considers, roughly, that the tides result from the pull which the sun and the moon exert upon the sea, causing it to act as a sort of break upon the solid earth." (Anniv. Address to Geol. Soc., 1869.)

A liquid earth takes a shape which follows from its rate of revolution, and from which, therefore, its rate of revolution can be calculated.

The liquid earth consolidated in the form it last assumed, and this shape has persisted until now, and informs us of the rate of revolution at the time of consolidation. Comparing this with the present rate, and knowing the amount of lengthening in a given time due to tidal friction, we can calculate the date of consolidation as certainly less than 1000 million years ago.

This argument is fallacious, as many mathematicians have shown. The present shape tells us nothing of the length of the day at the date of consolidation; for the earth, even when solid, will alter its form when exposed for a long time to the action of great forces. As Prof. Perry said in a letter to Prof. Tait (NATURE, January 3, 1895): "I know that solid rock is not like cobbler's wax, but 1000 million years is a very long time, and the forces are great." Furthermore, we know that the earth is always altering its shape, and that whole coast-lines are slowly rising or falling, and that this has been true, at any rate, during the formation of the stratified rocks.

This argument is dead and gone. We are, indeed, tempted to wonder that the physicist, who was looking about for arguments by which to revise what he conceived to be the hasty conclusions of the geologist as to the age of the earth, should have exposed himself to such an obvious retort in basing his own conclusions as to its age on the assumption that the earth, which we know to be always changing in shape, has been unable to alter its equatorial radius by a few miles under the action of tremendous forces constantly tending to alter it, and having 1000 million years in which to do the work.

With this flaw in the case it is hardly necessary to insist on our great uncertainty as to the rate at which the tides are lengthening the day.

The spectacle presented by the geologist and biologist, deeply shocked at Lord Kelvin's extreme uniformitarianism in the domain of astronomy and cosmic physics, is altogether too comforting to be passed by without remark; but in thus indulging in a friendly *tu quoque*, I am quite sure that I am speaking for every member of this Section in saying that we are in no way behind the members of Section A in our pride and admiration at the noble work which he has done for science, and we are glad to take this opportunity of congratulating him on the half-century of work and teaching—both equally fruitful—which has reached its completion in the present year.

The second argument is based upon the cooling of the earth, and this is the one brought forward and explained by Lord Salisbury in his Presidential Address. It has been the argument on which perhaps the chief reliance has been placed, and of which the data—so it was believed—were the least open to doubt.

On the Sunday during the meeting of the British Association at Leeds (1890), I went for a walk with Prof. Perry, and asked him to explain the physical reasons for limiting the age of the earth to a period which the students of other sciences considered to be very inadequate. He gave me an account of the data on which Lord Kelvin relied in constructing this second argument, and expressed the strong opinion that they were perfectly sound, while, as for the mathematics, it might be taken for granted, he said, that they were entirely correct. He did not attach much weight to the other arguments, which he regarded as merely offering support to the second.

This little piece of personal history is of interest, inasmuch as Prof. Perry has now provided us with a satisfactory answer to the line of reasoning which so fully satisfied him in 1890. And he was led to a critical examination of the subject by the attitude taken up by Lord Salisbury in 1894. Prof. Perry was not present at the meeting, but when he read the President's address, and saw how other conclusions were ruled out of court, how the only theory of evolution which commands anything approaching universal assent was set on one side because of certain assumptions as to the way in which the earth was believed to have cooled, he was seized with a desire to sift these assumptions, and to inquire whether they would bear the weight of such far-reaching conclusions. Before giving the results of his examination, it is necessary to give a brief account of the argument on which so much has been built.

Lord Kelvin assumed that the earth is a homogeneous mass of rock similar to that with which we are familiar on the surface. Assuming, further, that the temperature increases, on the average 1° F. for every 50 feet of depth near the surface everywhere, he concluded that the earth would have occupied not less than twenty, nor more than four hundred, million years in reaching its present condition from the time when it first began to consolidate and possessed a uniform temperature of 7000° F.

If, in the statement of the argument, we substitute for the assumption of a homogeneous earth an earth which conducts heat better internally than it does towards the surface, Prof. Perry, whose calculations have been verified by Mr. O. Heaviside, finds that the time of cooling has to be lengthened to an extent which depends upon the value assigned to the internal conducting power. If, for instance, we assume that the deeper part of the earth conducts ten times as well as the outer part, Lord Kelvin's age would require to be multiplied by fifty-six. Even if the conductivity be the same throughout, the increase of density in the deeper part, by augmenting the capacity for heat of unit volume, implies a longer age than that conceded by Lord Kelvin. If the interior of the earth be fluid or contain fluid in a honeycomb structure, the rate at which heat can travel would be immensely increased by convection currents, and the age would have to be correspondingly lengthened. If, furthermore, such conditions, although not obtaining now, did obtain in past times, they will have operated in the same direction.

Prof. Tait, in his letter to Prof. Perry (published in NATURE of January 3, 1895), takes the entirely indefensible position that the latter is bound to prove the higher internal conductivity. The obligation is all on the other side, and rests with those who have pressed their conclusions hard and carried them far. These conclusions have been, as Darwin found them, one of our "sorest troubles"; but when it is admitted that there is just as much to be said for another set of assumptions leading to entirely different conclusions, our troubles are at an end, and we cease to be terrified by an array of symbols, however unintelligible to us. It would seem that Prof. Tait, without, as far as I can learn, publishing any independent calculations of the age of the earth, has lent the weight of his authority to a period of ten million years, or half of Lord Kelvin's minimum. But

in making this suggestion he apparently feels neither interest nor responsibility in establishing the data of the calculations which he borrowed to obtain therefrom a very different result from that obtained by their author.

Prof. Perry's object was not to substitute a more correct age for that obtained by Lord Kelvin, but rather to show that the data from which the true age could be calculated are not really available. We obtain different results by making different assumptions, and there is no sufficient evidence for accepting one assumption rather than another. Nevertheless, there is some evidence which indicates that the interior of the earth in all probability conducts better than the surface. Its far higher density is consistent with the belief that it is rich in metals, free or combined. Prof. Schuster concludes that the internal electric conductivity must be considerably greater than the external. Geologists have argued from the amount of folding to which the crust has been subjected that cooling must have taken place to a greater depth than 120 miles, as assumed in Lord Kelvin's argument. Prof. Perry's assumption would involve cooling to a much greater depth.

Prof. Perry's conclusion that the age of the habitable earth is lengthened by increased conductivity is the very reverse of that to which we should be led by a superficial examination of the case. Prof. Tait, indeed, in the letter to which I have already alluded, has said: "Why, then, drag in mathematics at all, since it is absolutely obvious that the better conductor the interior in comparison with the skin, the longer ago must it have been when the whole was at 7000° F., the state of the skin being as at present?" Prof. Perry, in reply, pointed out that one mathematician who had refuted the tidal retardation argument (Rev. M. H. Close, in R. Dublin Soc., February 1878), had assumed that the conditions described by Prof. Tait would have involved a shorter period of time. And it is probable that Lord Kelvin thought the same; for he had assumed conditions which would give the result—so he believed at the time—most acceptable to the geologist and biologist. Prof. Perry's conclusion is very far from obvious, and without the mathematical reasoning would not be arrived at by the vast majority of thinking men.

The "natural man" without mathematics would say, so far from this being "absolutely obvious," it is quite clear that increased conductivity, favouring escape of heat, would lead to more rapid cooling, and would make Lord Kelvin's age even shorter.

The argument can, however, be put clearly without mathematics, and, with Prof. Perry's help, I am able to state it in a few words. Lord Kelvin's assumption of an earth resembling the surface rock in its relations to heat leads to the present condition of things, namely, a surface gradient of 1° F. for every 50 feet, in 100,000,000 years, more or less. Deeper than 150 miles he imagines that there has been almost no cooling. If, however, we take one of the cases put by Prof. Perry, and assume that below a depth of four miles there is ten times the conductivity, we find that after a period of 10,000,000,000 years the gradient at the surface is still 1° F. for every 50 feet; but that we have to descend to a depth of 1500 miles before we find the initial temperature of 7000° F. undiminished by cooling. In fact the earth, as a whole, has cooled far more quickly than under Lord Kelvin's conditions, the greater conductivity enabling a far larger amount of the internal heat to escape; but in escaping it has kept up the temperature gradient at the surface.

Lord Kelvin, replying to Prof. Perry's criticisms, quite admits that the age at which he had arrived by the use of this argument may be insufficient. Thus, he says, in his letter (NATURE, January 3, 1895): "I thought my range from 20 millions to 400 millions was probably wide enough, but it is quite possible that I should have put the superior limit a good deal higher, perhaps 4000 instead of 400."

The third argument was suggested by Helmholtz, and depends on the life of the sun. If the energy of the sun is due only to the mutual gravitation of its parts, and if the sun is now of uniform density, "the amount of heat generated by his contraction to his present volume would have been sufficient to last 18 million years at his present rate of radiation." (Newcomb's "Popular Astronomy," p. 523). Lord Kelvin rejects the assumption of uniform density, and is, in consequence of this change, able to offer a much higher upward limit of 500 million years

This argument also implies the strictest uniformitarianism as regards the sun. We know that other suns may suddenly gain a great accession of energy, so that their radiation is immensely increased. We only detect such changes when they are large and sudden, but they prepare us to believe that smaller accessions may be much more frequent, and perhaps a normal occurrence in the evolution of a sun. Such accessions may have followed from the convergence of a stream of meteors. Again, it is possible that the radiation of the sun may have been diminished and his energy conserved by a solar atmosphere.

Newcomb has objected to these two possible modes by which the life of the sun may have been greatly lengthened, that a lessening of the sun's heat by under a quarter would cause all the water on the earth to freeze, while an increase of much over half would probably boil it all away. But such changes in the amount of radiation received would follow from a greater distance from the sun of $15\frac{1}{2}$ per cent., and a greater proximity to him of 18·4 per cent., respectively. Venus is inside the latter limit, and Mars outside the former, and yet it would be a very large assumption to conclude that all the water in the former is steam, and all in the latter ice. Indeed, the existence of water and the melting of snow on Mars are considered to be thoroughly well authenticated. It is further possible that in a time of lessened solar radiation the earth may have possessed an atmosphere which would retain a larger proportion of the sun's heat; and the internal heat of the earth itself, great lakes of lava under a canopy of cloud for example, may have played an important part in supplying warmth.

Again we have a greater age if there was more energy available than in Helmholtz's hypothesis. Lord Kelvin maintains that this is improbable because of the slow rotation of the sun, but Perry has given reasons for an opposite conclusion.

The collapse of the first argument of tidal retardation, and of the second of the cooling of the earth, warn us to beware of a conclusion founded on the assumption that the sun's energy depends, and has ever depended, on a single source of which we know the beginning and the end. It may be safely maintained that such a conclusion has not that degree of certainty which justifies the followers of one science in assuming that the conclusion of other sciences must be wrong, and in disregarding the evidence brought forward by workers in other lines of research.

We must freely admit that this third argument has not yet fully shared the fate of the two other lines of reasoning. Indeed, Prof. George Darwin, although attacking these latter, agrees with Lord Kelvin in regarding 500 million years as the maximum life of the sun. (*British Association Reports*, 1886, pp. 514–518.)

We may observe, too, that 500 million years is by no means to be despised: a great deal may happen in such a period of time. Although I should be very sorry to say that it is sufficient, it is a very different offer from Prof. Tait's 10 million.

In drawing up this account of the physical arguments, I owe almost everything to Prof. Perry for his articles in NATURE (January 3 and April 18, 1895), and his kindness in explaining any difficulties that arose. I have thought it right to enter into these arguments in some detail, and to consume a considerable proportion of our time in their discussion. This was imperatively necessary, because they claimed to stand as barriers across our path, and, so long as they were admitted to be impassable, any further progress was out of the question. What I hope has been an unbiassed examination has shown that, as barriers, they are more imposing than effective: and we are free to proceed, and to look for the conclusions warranted by our own evidence. In this matter we are at one with the geologists; for, as has already been pointed out, we rely on them for an estimate of the time occupied by the deposition of the stratified rocks, while they rely on us for a conclusion as to how far this period is sufficient for the whole of organic evolution.

First, then, we must briefly consider the geological argument, and I cannot do better than take the case as put by Sir Archibald Geikie in his Presidential Address to this Association at Edinburgh in 1892.

Arguing from the amount of material removed from the land by denuding agencies, and carried down to the sea by rivers, he showed that the time required to reduce the height of the land by one foot, varies, according to the activity of the agencies at work, from 730 years to 6800 years. But this also supplies a

measure of the rate of deposition of rock; for the same material is laid down elsewhere, and would of course add the same height of one foot to some other area equal in size to that from which it was removed.

The next datum to be obtained is the total thickness of the stratified rocks from the Cambrian system to the present day. "On a reasonable computation these stratified masses, where most fully developed, attain a united thickness of not less than 100,000 feet. If they were all laid down at the most rapid recorded rate of denudation, they would require a period of seventy-three millions of years for their completion. If they were laid down at the slowest rate, they would demand a period of not less than 680 millions."

The argument that geological agencies acted much more vigorously in past times he entirely refuted by pointing to the character of the deposits of which the stratified series is composed. "We can see no proof whatever, nor even any evidence which suggests that on the whole the rate of waste and sedimentation was more rapid during Mesozoic and Palæozoic time than it is to-day. Had there been any marked difference in this rate from ancient to modern times, it would be incredible that no clear proof of it should have been recorded in the crust of the earth."

It may therefore be inferred that the rate of deposition was no nearer the more rapid than the slower of the rates recorded above, and, if so, the stratified rocks would have been laid down in about 400 million years.

There are other arguments favouring the uniformity of conditions throughout the time during which the stratified rocks were laid down, in addition to those which are purely geological and depend upon the character of the rocks themselves. Although more biological than geological, these arguments are best considered here.

The geological agency to which attention is chiefly directed by those who desire to hurry up the phenomena of rock formation is that of the tides. But it seems certain that the tides were not sufficiently higher in Silurian times to prevent the deposition of certain beds of great thickness under conditions as tranquil as any of which we have evidence in the case of a formation extending over a large area. From the character of the organic remains it is known that these beds were laid down in the sea, and there are the strongest grounds for believing that they were accumulated along shores and in fairly shallow water. The remains of extremely delicate organisms are found in immense numbers, and over a very large area. The recent discovery, in the Silurian system of America, of trilobites, with their long delicate antennæ perfectly preserved, proves that in one locality (Rome, New York State) the tranquillity of deposition was quite as profound as in any locality yet discovered on this side of the Atlantic.

There are, then, among the older Palæozoic rocks a set of deposits than which we can imagine none better calculated to test the force of the tides; and we find that they supply evidence for exceptional tranquillity of conditions over a long period of time.

There is other evidence of the permanence, throughout the time during which the stratified rocks were deposited, of conditions not very dissimilar from those which obtain to-day. Thus the attachments of marine organisms, which are permanently rooted to the bottom or on the shores, did not differ in strength from those which we now find—an indication that the strains due to the movements of the sea did not greatly differ in the past.

We have evidence of a somewhat similar kind to prove uniformity in the movements of the air. The expanse of the wings of flying organisms certainly does not differ in a direction which indicates any greater violence in the atmospheric conditions. Before the birds had become dominant among the larger flying organisms, their place was taken by the flying reptiles, the pterodactyls, and before the appearance of these we know that, in Palæozoic times, the insects were of immense size, a dragon-fly from the Carboniferous rocks of France being upwards of two feet in the expanse of its wings. As one group after another of widely dissimilar organisms gained control of the air, each was in turn enabled to increase to the size which was best suited to such an environment, but we find that the limits which obtain to-day were not widely different in the past. And this is evidence for the uniformity in the strains due to wind and storm no less than to those due to gravity. Furthermore, the condition of the earth's surface at present shows us how extremely sensitive the flying organism is to an increase in the former of these strains, when it occurs in proximity to the sea. Thus it is well known that an unusually large proportion of the Madeiran beetles are wingless, while those which require the power of flight possess it in a stronger degree than on continental areas. This evolution in two directions is readily explained by the destruction by drowning of the winged individuals of the species which can manage to live without the power of flight, and of the less strongly winged individuals of those which need it. Species of the latter kind cannot live at all in the far more stormy Kerguelen Land, and the whole of the insect fauna is wingless.

The size and strength of the trunks of fossil trees afford, as Prof. George Darwin has pointed out, evidence of uniformity in the strains due to the condition of the atmosphere.

We can trace the prints of raindrops at various geological horizons, and in some cases found in this country it is even said that the eastern side of the depressions is the more deeply pitted, proving that the rain drove from the west, as the great majority of our storms do to-day.

When, therefore, we are accused of uniformitarianism, as if it were an entirely unproved assumption, we can at any rate point to a large body of positive evidence which supports our contention, and the absence of any evidence against it. Furthermore, the data on which we rely are likely to increase largely, as the result of future work.

After this interpolation, chiefly of biological argument in support of the geologist, I cannot do better than bring the geological evidence to a close in the words which conclude Sir Archibald Geikie's address: "After careful reflection on the subject, I affirm that the geological record furnishes a mass of evidence which no arguments drawn from other departments of nature can explain away, and which, it seems to me, cannot be satisfactorily interpreted save with an allowance of time much beyond the narrow limits which recent physical speculation would concede."

In his letter to Prof. Perry (NATURE, January 3, 1895), Lord Kelvin says:—

"So far as underground heat alone is concerned, you are quite right that my estimate was 100 million, and please remark (*P. L. and A.*, vol. ii. p. 87) that that is all Geikie wants; but I should be exceedingly frightened to meet him now with only 20 million in my mouth."

We have seen, however, that Geikie considered the rate of sedimentation to be, on the whole, uniform with that which now obtains, and this would demand a period of nearly 400 million years. He points out furthermore that the time must be greatly increased on account of the breaks and interruptions which occur in the series, so that we shall probably get as near an estimate as is possible from the data which are available by taking 450 million as the time during which the stratified rocks were formed.

Before leaving this part of the subject, I cannot refrain from suggesting a line of enquiry which may very possibly furnish important data for checking the estimates at present formed by geologists, and which, if the mechanical difficulties can be overcome, is certain to lead to results of the greatest interest and importance. Ever since the epoch-making voyage of the *Challenger*, it has been known that the floor of the deep oceans outside the yellow shelf which fringes the continental areas is covered by a peculiar deposit formed entirely of meteoric and volcanic dust, the waste of floating pumice, and the hard parts of animals living in the ocean. Of these latter only the most resistant can escape the powerful solvent agencies. Many observations prove that the accumulation of this deposit is extremely slow. One indication of this is especially convincing: the teeth of sharks and the most resistant part of the skeleton—the ear-bones—of whales are so thickly spread over the surface that they are continually brought up in the dredge, while sometimes a single haul will yield a large number of them. Imagine the countless generations of sharks and whales which must have succeeded each other in order that these insignificant portions of them should be so thickly spread over that vast area which forms the ocean floor. We have no reason to suppose that sharks and whales die more frequently in the deep ocean than in the shallow fringing seas; in fact, many observations point in the opposite direction, for wounded and dying whales often enter shallow creeks and inlets, and not uncommonly become stranded. And yet these remains of sharks and whales, although well known in the stratified rocks which were laid down in

comparatively shallow water and near coasts, are only found in certain beds, and then in far less abundance than in the oceanic deposit. We can only explain this difference by supposing that the latter accumulate with such almost infinite slowness as compared with the continental deposits that these remains form an important and conspicuous constituent of the one, while they are merely found here and there when looked for embedded in the other. The rate of accumulation of all other constituents is so slow as to leave a layer of teeth and ear-bones uncovered, or covered by so thin a deposit that the dredge can collect them freely. Dr. John Murray calculates that only a few inches of this deposit have accumulated since the Tertiary Period. These most interesting facts prove furthermore that the great ocean basins and continental areas have occupied the same relative positions since the formation of the first stratified rocks; for no oceanic deposits are found anywhere in the latter. We know the sources of the oceanic deposit, and it might be possible to form an estimate, within wide limits, of its rate of accumulation. If it were possible to ascertain its thickness by means of a boring, some conclusions as to the time which has elapsed during the lifetime of certain species—perhaps even the lifetime of the oceans themselves—might be arrived at. Lower down the remains of earlier species would probably be found. The depth of this deposit and its character at deeper levels are questions of overwhelming interest; and perhaps even more so is the question as to what lies beneath. Long before the *Challenger* had proved the persistence of oceanic and continental areas, Darwin, with extraordinary foresight, and opposed by all other naturalists and geologists, including his revered teacher, Lyell, had come to the same conclusion. His reasoning on the subject is so convincing that it is remarkable that he made so few converts, and this is all the more surprising since the arguments were published in the "Origin of Species," which in other respects produced so profound an effect. In speculating as to the rocks in which the remains of the ancestors of the earliest known fossils may still exist, he suggested that, although the existing relationship between the positions of our present oceans and continental areas is of immense antiquity, there is no reason for the belief that it has persisted for an indefinite period, but that at some time long antecedent to the earliest known fossiliferous rocks "continents may have existed where oceans are now spread out; and clear and open oceans may have existed where our continents now stand." Not the least interesting result would be the test of this hypothesis, which would probably be forthcoming as the result of boring into the floor of a deep ocean; for although, as Darwin pointed out, it is likely enough that such rocks would be highly metamorphosed, yet it might still be possible to ascertain whether they had at any time formed part of a continental deposit, and perhaps to discover much more than this. Such an undertaking might be carried out in conjunction with other investigations of the highest interest, such as the attempt to obtain a record of the swing of a pendulum at the bottom of the ocean.

We now come to the strictly biological part of our subject—to the inquiry as to how much of the whole scheme of organic evolution has been worked out in the time during which the fossiliferous rocks were formed, and how far, therefore, the time required by the geologist is sufficient.

It is first necessary to consider Lord Kelvin's attempt to rescue us from the dilemma in which we were placed by the insufficiency of time for evolution—the suggestion that life may have reached the earth on a meteorite. According to this view, the evolution which took place elsewhere may have been merely completed, in a comparatively brief space of time, on our earth.

We know nothing of the origin of life here or elsewhere, and our only attitude towards this or any other hypothesis on the subject is that of the anxious inquirer for some particle of evidence. But a few brief considerations will show that no escape from the demands for time can be gained in this way.

Our argument does not deal with the time required for the origin of life, or for the development of the lowest beings with which we are acquainted from the first formed beings, of which we know nothing. Both these processes may have required an immensity of time; but as we know nothing whatever about them, and have as yet no prospect of acquiring any information, we are compelled to confine ourselves to as much of the process of evolution as we can infer from the structure of living and fossil forms—that is, as regards animals, to the development of the simplest into the most complex Protozoa, the evolution of the Metazoa from the Protozoa, and the branching of the former into its numerous Phyla, with all their Classes, Orders, Families, Genera, and Species. But we shall find that this is quite enough to necessitate a very large increase in the time estimated by the geologist.

The Protozoa, simple and complex, still exist upon the earth in countless species, together with the Metazoan Phyla. Descendants of forms which in their day constituted the beginning of that scheme of evolution which I have defined above, descendants, furthermore, of a large proportion of those forms which, age after age, constituted the shifting phases of its onward progress, still exist, and in a sufficiently unmodified condition to enable us to reconstruct, at any rate in mere outline, the history of the past. Innumerable details and many phases of supreme importance are still hidden from us, some of them perhaps never to be recovered. But this frank admission, and the eager and premature attempts to expound too much, to go further than the evidence permits, must not be allowed to throw an undeserved suspicion upon conclusions which are sound and well supported, upon the firm conviction of every zoologist that the general trend of evolution has been, as I have stated it, that each of the Metazoan Phyla originated, directly or indirectly, in the Protozoa.

The meteorite theory would, however, require that the process of evolution went backward on a scale as vast as that on which it went forward, that certain descendants of some central type, coming to the earth on a meteorite, gradually lost their Metazoan complexity and developed backward into the Protozoa, throwing off the lower Metazoan Phyla on the way, while certain other descendants evolved all the higher Metazoan groups. Such a process would shorten the period of evolution by half, but it need hardly be said that all available evidence is entirely against it.

The only other assumption by means of which the meteorite hypothesis would serve to shorten the time is even more wild and improbable. Thus it might be supposed that the evolution which we believe to have taken place on this earth, really took place elsewhere—at any rate as regards all its main lines—and that samples of all the various phases, including the earliest and simplest, reached us by a regular meteoric service, which was established at some time after the completion of the scheme of organic evolution. Hence the evidences which we study would point to an evolution which occurred in some unknown world with an age which even Prof. Tait has no desire to limit.

If these wild assumptions be rejected, there remains the supposition that, if life was brought by a meteorite, it was life no higher than that of the simplest Protozoon—a supposition which leaves our argument intact. The alternative supposition, that one or more of the Metazoan Phyla were introduced in this way while the others were evolved from the terrestrial Protozoa, is hardly worth consideration. In the first place, some evidence of a part in a common scheme of evolution is to be found in every Phylum. In the second place, the gain would be small; the arbitrary assumption would only affect the evidence of the time required for evolution derived from the particular Phylum or Phyla of supposed meteoric origin.

The meteoric hypothesis, then, can only affect our argument by making the most improbable assumptions, for which, moreover, not a particle of evidence can be brought forward.

We are therefore free to follow the biological evidence fearlessly. It is necessary, in the first place, to expand somewhat the brief outline of the past history of the animal kingdom, which has already been given. Since the appearance of the "Origin of Species," the zoologist, in making his classifications, has attempted as far as possible to set forth a genealogical arrangement. Our purpose will be served by an account of the main outlines of a recent classification, which has been framed with a due consideration for all sides of zoological research, new and old, and which has met with general approval. Prof. Lankester divides the animal kingdom into two grades, the higher of which, the Enterozoa (Metazoa), were derived from the lower, the Plastidozoa (Protozoa). Each of these grades is again divided into two sub-grades, and each of these is again divided into Phyla, corresponding more or less to the older Sub-Kingdoms. Beginning from below, the most primitive animals in existence are found in the seven Phyla of the lower Protozoan sub-grade, the Gymnomyxa. Of these unfortunately only two, the Reticularia (Foraminifera) and Radiolaria, possess a structure which renders possible their preservation in the

rocks. The lowest and simplest of these Gymnomyxa represent the starting-point of that scheme of organic evolution which we are considering to-day. The higher order of Protozoan life, the sub-grade Corticata, contains three Phyla, no one of which is available in the fossil state. They are, however, of great interest and importance to us as showing that the Protozoan type assumes a far higher organisation on its way to evolve the more advanced grade of animal life. The first-formed of these latter are contained in the two Phyla of the sub-grade Cœlentera, the Porifera or Sponges, and the Nematophora or Corals, Sea-Anemones, Hydrozoa and allied groups. Both of these Phyla are plentifully represented in the fossil state. It is considered certain that the latter of these, the Nematophora, gave rise to the higher sub-grade, the Cœlomata, or animals with a cœlom or body-cavity surrounding the digestive tract. This latter includes all the remaining species of animals in nine Phyla, five of which are found fossil—the Echinoderma, Gephyrea, Mollusca, Appendiculata, and Vertebrata.

Before proceeding further, I wish to lay emphasis on the immense evolutionary history which must have been passed through before the ancestor of one of the higher of these nine Phyla came into being. Let us consider one or two examples, since the establishment of this position is of the utmost importance for our argument. First, consider the past history of the Vertebrata—of the common ancestor of our Balanoglossus, Tunicates, Amphioxus, Lampreys, Fishes, Dipnoi, Amphibia, Reptiles, Birds, and Mammals. Although zoologists differ very widely in their opinions as to the affinities of this ancestral form, they all agree in maintaining that it did not arise direct from the Nematophora in the lower sub-grade of Metazoa, but that it was the product of a long history within the Cœlomate sub-grade. The question as to which of the other Cœlomate Phyla it was associated with will form the subject of one of our discussions at this meeting; and I will therefore say no more upon this period of its evolution, except to point out that the very question itself, "the ancestry of Vertebrates," only means a relatively small part of the evolutionary history of the Vertebrate ancestor within the Cœlomate group. For when we have decided the question of the other Cœlomate Phylum or Phyla to which the ancestral Vertebrate belonged, there remains of course the history of that Phylum or those Phyla earlier than the point at which the Vertebrate diverged, right back to the origin of the Cœlomata; while, beyond and below, the wide gulf between this and the Cœlentera had to be crossed, and then, probably after a long history as a Cœlenterate, the widest and most significant of all the morphological intervals—that between the lowest Metazoon and the highest Protozoon—was traversed. But this was by no means all. There remains the history within the higher Protozoan sub-grade, in the interval from this to the lower, and within the lower sub-grade itself, until we finally retrace our steps to the lowest and simplest forms. It is impossible to suppose that all this history of change can have been otherwise than immensely prolonged; for it will be shown below that all the available evidence warrants the belief that the changes during these earlier phases were at least as slow as those which occurred later.

If we take the history of another of the higher Phyla, the Appendiculata, we find that the evidence points in the same direction. The common ancestor of our Rotifera, earthworms, leeches, Peripatus, centipedes, insects, Crustacea, spiders and scorpions, and forms allied to all these, is generally admitted to have been Chætopod-like, and probably arose in relation to the beginnings of certain other Cœlomata Phyla, such as the Gephyrea and perhaps Mollusca. At the origin of the Cœlomate sub-grade, the common ancestor of all Cœlomate Phyla is reached, and its evolution has been already traced in the case of the Vertebrata.

What is likely to be the relation between the time required for the evolution of the ancestor of a Cœlomate Phylum and that required for the evolution, which subsequently occurred, within the Phylum itself? The answer to this question depends mainly upon the rate of evolution in the lower parts of the animal kingdom as compared with that in the higher. Contrary, perhaps, to anticipation, we find that all the evidences of rapid evolution are confined to the most advanced of the smaller groups within the highest Phyla, and especially to the higher classes of the Vertebrata. Such evidence as we have strongly indicates the most remarkable persistence of the lower animal types. Thus in the class Imperforata of the Reticularia (Foraminifera) one of our existing genera (*Saccamina*) occurs in the Carboniferous strata, another (*Trochammina*) in the Permian, while a single new genus (*Receptaculites*) occurs in the Silurian and Devonian. The evidence from the class Perforata is much stronger, the existing genera *Nodosaria*, *Dentalina*, *Textularia*, *Grammostomum*, *Valvulina*, and *Nummulina* all occurring in the Carboniferous, together with the new genera *Archædiscus* (?) and *Fusulina*.

I omit reference to the much-disputed Eozoon from the Laurentian rocks far below the horizon, which for the purpose of this address I am considering as the lowest fossiliferous stratum. We are looking forward to the new light which will be thrown upon this form in the communication of its veteran defender, Sir William Dawson, whom we are all glad to welcome.

Passing the Radiolaria, with delicate skeletons less suited for fossilisation, and largely pelagic and therefore less likely to reach the strata laid down along the fringes of the continental areas, the next Phylum which is found in a fossil state is that of the Porifera, including the sponges, and divided into two classes, the Calcispongiæ and Silicospongiæ. Although the fossilisation of sponges is in many cases very incomplete, distinctly recognisable traces can be made out in a large number of strata. From these we know that representatives of all the groups of both classes (except the Halisarcidæ, which have no hard parts) occurred in the Silurian, Devonian, and Carboniferous systems. The whole Phylum is an example of long persistence with extremely little change. And the same is true of the Nematophora: new groups indeed come in, sometimes extremely rich in species, such as the Palæozoic Rugose corals and Graptolites; but they existed side by side with representatives of existing groups, and they are not in themselves primitive or ancestral. A study of the immensely numerous fossil corals reveals no advance in organisation, while researches into the structure of existing Alcyonaria and Hydrocorallina have led to the interpretation of certain Palæozoic forms which were previously obscure, and the conclusion that they find their place close beside the living species.

All available evidence points to the extreme slowness of progressive evolutionary changes in the Cœlenterate Phyla, although the Protozoa, if we may judge by the Reticularia (Foraminifera), are even more conservative.

When we consider later on the five Cœlomate Phyla which occur fossil, we shall find that the progressive changes were slower and indeed hardly appreciable in the two lower and less complex Phyla, viz. the Echinoderma and Gephyrea, as compared with the Mollusca, Appendiculata, and Vertebrata.

Within these latter Phyla we have evidence for the evolution of higher groups presenting a more or less marked advance in organisation. And not only is the rate of development more rapid in the highest Phyla of the animal kingdom, but it appears to be most rapid when dealing with the highest animal tissue, the central nervous system. The chief, and doubtless the most significant, difference between the early Tertiary mammals and those which succeeded them, between the Secondary and Tertiary reptiles, between man and the mammals most nearly allied to him, is a difference in the size of the brain. In all these cases an enormous increase in this, the dominant tissue of the body, has taken place in a time which, geologically speaking, is very brief.

When speaking later on upon the evolution which has taken place within the Phyla, further details upon this subject will be given, although in this as in other cases, the time at our disposal demands that the exposition of evidence must largely yield to an exposition of the conclusions which follow from its study. And undoubtedly a study of all the available evidence points very strongly to the conclusion that in the lower grade, sub-grades, and Phyla of the animal kingdom, evolution has been extremely slow as compared with that in the higher. We do not know the reason. It may be that this remarkable persistence through the stratified series of deposits is due to an innate fixity of constitution which has rigidly limited the power of variation; or, more probably perhaps, that the lower members of the animal kingdom were, as they are now, more closely confined to particular environments, with particular sets of conditions, with which they had to cope, and, this being successfully accomplished, natural selection has done little more than keep up a standard of organisation which was sufficient for their needs; while the higher and more aggressive forms ranging over many environments, and always prone to encounter new sets of conditions, were compelled to undergo responsive changes or to succumb. But whatever be the cause, the fact remains, and is of the highest importance for our argument. When the ancestor

of one of the higher Phyla was associated with the lower Phyla of the Cœlomate sub-grade, when further back it passed through a Cœlenterate, a higher Protozoan, and finally a lower Protozoan phase, we must believe that its evolution was probably very slow as compared with the rate which it subsequently attained. But this conclusion is of the utmost importance; for the history contained in the stratified rocks nowhere reveals to us the origin of a Phylum. And this is not mere negative evidence, but positive evidence of the most unmistakable character. All the five Cœlomate Phyla which occur fossil appear low down in the Palaeozoic rocks, in the Silurian or Cambrian strata, and they are represented by forms which are very far from being primitive, or, if primitive, are persistent types, such as Chiton, which are now living. Thus Vertebrata are represented by fishes, both sharks and ganoids; the Appendiculata by cockroaches, scorpions, Limulids, Trilobites, and many Crustacea; the Mollusca by Nautilus and numerous allied genera, by Dentalium, Chiton, Pteropods, and many Gastropods and Lamellibranchs; the Gephyrea by very numerous Brachiopods, and many Polyzoa; the Echinoderma by Crinoids, Cystoids, Blastoids, Asteroids, Ophiuroids, and Echinoids. It is just conceivable, although, as I believe, most improbable, that the Vertebrate Phylum originated at the time when the earliest known fossiliferous rocks were laid down. It must be remembered, however, that an enormous morphological interval separates the fishes which appear in the Silurian strata from the lower branches, grades, and classes of the Phylum in which Balanoglossus, the Ascidians, Amphioxus, and the Lampreys are placed. The earliest Vertebrates to appear are, in fact, very advanced members of the Phylum, and, from the point of view of anatomy, much nearer to man than to Amphioxus. If, however, we grant the improbable contention that so highly organised an animal as a shark could be evolved from the ancestral vertebrate in the period which intervened between the earliest Cambrian strata and the Upper Silurian, it is quite impossible to urge the same with regard to the other Phyla. It has been shown above that when these appear in the Cambrian and Silurian, they are flourishing in full force, while their numerous specialised forms are a positive proof of a long antecedent history within the limits of the Phylum.

If, however, we assume for a moment that the Phyla began in the Cambrian, the geologist's estimate must still be increased considerably, and perhaps doubled, in order to account for the evolution of the higher Phyla from forms as low as many which are now known upon the earth; unless, indeed, it is supposed, against the whole weight of all such evidence as is available, that the evolutionary history in these early times was comparatively rapid.

To recapitulate, if we represent the history of animal evolution by the form of a tree, we find that the following growth took place in some age antecedent to the earliest fossil records, before the establishment of the higher Phyla of the Animal Kingdom. The main trunk, representing the lower Protozoa divided, originating the higher Protozoa; the latter portion again divided, probably in a threefold manner, originating the two lowest Metazoan Phyla, constituting the Cœlentera. The branch representing the higher of these Phyla, the Nematophora, divided, originating the lower Cœlomate Phyla, which again branched and originated the higher Phyla. And, as has been shown above, the relatively ancestral line, at every stage of this complex history, after originating some higher line, itself continued down to the present day, throughout the whole series of fossiliferous rocks, with but little change in its general characters, and practically nothing in the way of progressive evolution. Evidences of marked advance are to be found alone in the most advanced groups of the latest highest products—the Phyla formed by the last of these divisions.

It may be asked how is it possible for the zoologist to feel so confident as to the past history of the various animal groups? I have already explained that he does not feel this confidence as regards the details of the histoyr, but as to its general lines. The evidence which leads to this conviction is based upon the fact that animal structure and mode of development can be, and have been, handed down from generation to generation from a period far more remote than that which is represented by the earliest fossils; that fundamental facts in structure and development may remain changeless amid endless changes of a more general character; that especially favourable conditions have preserved ancestral forms comparatively unchanged. Working upon this material, comparative anatomy and embryology can reconstruct for us the general aspects of a history which took place long before the Cambrian rocks were deposited. This line of reasoning may appear very speculative and unsound, and it may easily become so when pressed too far. But applied with due caution and reserve, it may be trusted to supply us with an immense amount of valuable information which cannot be obtained in any other way. Furthermore, it is capable of standing the very true and searching test supplied by the verification of predictions made on its authority. Many facts taken together lead the zoologist to believe that A was descended from C through B; but if this be true, B should possess certain characters which are not known to belong to it. Under the inspiration of hypothesis a more searching investigation is made, and the characters are found. Again, that relatively small amount of the whole scheme of animal evolution which is contained in the fossiliferous rocks has furnished abundant confirmation of the validity of the zoologist's method. The comparative anatomy of the higher Vertebrate Classes leads the zoologist to believe that the toothless beak and the fused caudal vertebræ of a bird were not ancestral characters, but were at some time derived from a condition more comfortable to the general plan of vertebrate construction, and especially to that of reptiles. Numerous secondary fossils prove to us that the birds of that time possessed teeth and separate caudal vertebræ, culminating in the long lizard-like tail of Archæopteryx.

Prediction and confirmation of this kind, both zoological and palæontological, have been going on ever since the historic point of view was adopted by the naturalist as the outcome of Darwin's teaching, and the zoologist may safely claim that his method, confirmed by palæontology so far as evidence is available, may be extended beyond the period in which such evidence is to be found.

And now our last endeavour must be to obtain some conception of the amount of evolution which has taken place within the higher Phyla of the Animal Kingdom during the period in which the fossiliferous rocks were deposited. The evidence must necessarily be considered very briefly, and we shall be compelled to omit the Vertebrata altogether.

The Phylum Appendiculata is divided by Lankester into three branches, the first containing the Rotifera, the second the Chætopoda, the third the Arthropoda. Of these the second is the oldest, and gave rise to the other two, or, at any rate, to the Arthropoda, with which we are alone concerned, inasmuch as the fossil records of the others are insufficient. The Arthropoda contain seven Classes, divided into two grades, according to the presence or absence of antennæ—the Ceratophora, containing the Peripatoidea, the Myriapoda, and the Hexapoda (or insects); the Acerata, containing the Crustacea, Arichnida, and two other classes (the Pantopoda and Tardigrada) which we need not consider The first Class of the antenna-bearing group contains the single genus Peripatus—one of the most interesting and ancestral of animals, as proved by its structure and development, and by its immense geographical range. Ever since the researches of Moseley and Balfour, extended more recently by those of Sedgwick, it has been recognised as one of the most beautiful of the connecting links to be found amongst animals, uniting the antenna-bearing Arthropods, of which it is the oldest member, with the Chætopods. Peripatus is a magnificent example of the far-reaching conclusions of zoology, and of its superiority to palæontology as a guide in unravelling the tangled history of animal evolution. Peripatus is alive to-day, and can be studied in all the details of its structure and development; it is infinitely more ancestral, and tells of a far more remote past than any fossil Arthropod, although such fossils are well known in all the older of the Palæozoic rocks. And yet Peripatus is not known as a fossil. Peripatus has come down, with but little change, from a time, on a moderate estimate, at least twice as remote as the earliest known Cambrian fossil. The agencies which, it is believed, have crushed and heated the Archæan rocks so as to obliterate the traces of life which they contained were powerless to efface this ancient type, for, although the passing generations may have escaped record, the likeness of each was stamped on that which succeeded it, and has continued down to the present day. It is, of course, a perfectly trite and obvious conclusion, but not the less one to be wondered at, that the force of heredity should thus far outlast the ebb and flow of terrestrial change throughout the vast period over which the geologist is our guide.

If, however, the older Palæozoic rocks tell us nothing of the origin of the antennæ-bearing Arthropods, what do they tell us of the history of the Myriapod and Hexapod Classes?

The Myriapods are well represented in Palæozoic strata, two species being found in the Devonian and no less than thirty-two

in the Carboniferous. Although placed in an Order (Archipolypoda) separate from those of living Myriapods, these species are by no means primitive, and do not supply any information as to the steps by which the Class arose. The imperfection of the record is well seen in the traces of this Class; for between the Carboniferous rocks and the Oligocene there are no remains of undoubted Myriapods.

We now come to the consideration of insects, of which an adequate discussion would occupy a great deal too much of your time. An immense number of species are found in the Palæozoic rocks, and these are considered by Scudder, the great authority on fossil insects, to form an Order, the Palæodictyoptera, distinct from any of the existing Orders. The latter, he believes, were evolved from the former in Mesozoic times. These views do not appear to derive support from the wonderful discoveries of M. Brongniart [1] in the Upper Carboniferous of Commentry in the Department of Allier in Central France. Concerning this marvellous assemblage of species, arranged by their discoverer into 46 genera and 101 species, Scudder truly says:

"Our knowledge of Palæozoic insects will have been increased three or fourfold at a single stroke. . . . No former contribution in this field can in any way compare with it, nor even all former contributions taken together." (S. H. Scudder, *Am. Journ. Sci.*, vol. xlvii., February 1894, Art. viii.)

When we remember that the group of fossil insects, of which so much can be affirmed by so great an authority as Scudder, lived at one time and in a single locality, we cannot escape the conclusion that the insect fauna of the habitable earth during the whole Palæozoic period was of immense importance and variety. Our knowledge of this single group of species is largely due to the accident that coal-mining in Commentry is carried on in the open air.

Now, these abundant remains of insects, so far from upholding the view that the existing orders had not been developed in Palæozoic times, are all arranged by Brongniart in four out of the nine orders into which insects are usually divided, viz. the Orthoptera, Neuroptera, Thysanoptera, and Homoptera. The importance of the discovery is well seen in the Neuroptera, the whole known Palæozoic fauna of this order being divided into 45 genera and 99 species, of which 33 and 72 respectively have been found at Commentry.

Although the Carboniferous insects of Commentry are placed in new families, some of them come wonderfully near those into which existing insects are classified, and obviously form the precursors of these. This is true of the Blattidæ, Phasmidæ, Acridiidæ, and Locustidæ among the Orthoptera, the Perlidæ among the Neuroptera, and the Fulgoridæ among the Homoptera. The differences which separate these existing families from their Carboniferous ancestors are most interesting and instructive. Thus the Carboniferous cockroaches possessed ovipositors, and probably laid their eggs one at a time, while ours are either viviparous or lay their eggs in a capsule. The Protophasmidæ resemble living species in the form of the head, antennæ, legs, and body; but while our species are either wingless or, with the exception of the female Phyllidæ, have the anterior pair reduced to tegmina, useless for flight, those of Palæozoic times possessed four well-developed wings. The forms representing locusts and grasshoppers (Palæacrididæ) possessed long slender antennæ like the green grasshoppers (Locustididæ), from which the Acridiidæ are now distinguished by their short antennæ. The divergence and specialisation which is thus shown is amazingly small in amount In the vast period between the Upper Carboniferous rocks and the present day the cockroaches have gained a rather different wing venation, and have succeeded in laying their eggs in a manner rather more specialised than that of insects in geneial; the stick insects and leaf insects have lost or reduced their wings, the grasshoppers have shortened their antennæ. These, however, are the insects which most closely resemble the existing species; let us turn to the forms which exhibit the greatest differences. Many species have retained in the adult state characters which are now confined to the larval stage of existence, such as the presence of tracheal gills on the sides of the abdomen. In some the two membranes of the wing were not firmly fixed together, so that the blood could circulate freely between them. On the other hand, they are not very firmly fixed together in existing insects. Another important point was the condition of the three thoracic segments, which were quite distinct and separate, instead of being fused as they are now in the imago stage. This external difference probably also extended to the nervous system, so that the thoracic ganglia were separate instead of concentrated The most interesting distinction, however, was the possession by many species of a pair of prothoracic appendages much resembling miniature wings, and which especially suggest the appearance assumed by the anterior pair (tegmina) in existing Phasmidæ. There is some evidence in favour of the view that they were articulated, and they exhibit what appears to be a trace of venation. Brongniart concludes that in still earlier strata, insects with six wings will be discovered, or rather insects with six of the tracheal gills sufficiently developed to serve as parachutes. Of these, the two posterior pair developed into the wings as we know them, while the anterior pair degenerated, some of the Carboniferous insects presenting us with a stage in which degeneration had taken place, but was not complete.

One very important character was, as I have already pointed out, the enormous size reached by insects in this distant period. This was true of the whole known fauna as compared with existing species, but it was especially the case with the Protodonata, some of these giant dragon-flies measuring over two feet in the expanse of the wings.

As regards the habits of life and metamorphoses, Brongniart concludes that some species of Protoephemeridæ, Protoperlidæ, &c., obtained their food in an aquatic larval stage, and did not require it when mature. He concludes that the Protodonata fed on other animals, like our dragon-flies; that the Palæacrididæ were herbivorous like our locusts and grasshoppers, the Protolocustidæ herbivorous and animal feeders like our green grasshoppers, the Palæoblattidæ omnivorous like our cockroaches. The Homoptera, too, had elongated sucking mouth-parts like the existing species. It is known that in Carboniferous times there was a lake with rivers entering it, at Commentry. From their great resemblance to living forms of known habits, it is probable that the majority of these insects lived near the water and their larvæ in it.

When we look at this most important piece of research as a whole, we cannot fail to be struck with the small advance in insect structure which has taken place since Carboniferous times. All the great questions of metamorphosis, and of the structures peculiar to insects, appear to have been very much in the position in which they are to-day. It is indeed probable enough that the orders which zoologists have always recognised as comparatively modern and specialised, such as the Lepidoptera, Coleoptera, and Hymenoptera, had not come into existence. But as regards the emergence of the Class from a single primitive group, as regards its approximation towards the Myriapods, which lived at the same time, and of both towards their ancestor Peripatus, we learn absolutely nothing. All we can say is that there is evidence for the evolution of the most modern and specialised members of the Class, and some slight evolution in the rest. Such evolution is of importance as giving us some vague conception of the rate at which the process travels in this division of the Arthropoda. If we look upon development as a series of paths which, by successively uniting, at length meet in a common point, then some conception of the position of that distant centre may be gained by measuring the angle of divergence and finding the number of unions which occur in a given length. In this case, the amount of approximation and union shown in the interval between the Carboniferous period and the present day is relatively so small that it would require to be multiplied many times before we could expect the lines to meet in the common point, the ancestor of insects, to say nothing of the far more distant past in which the Tracheate Arthropods met in an ancestor presenting many resemblances to Peripatus. But it must not be forgotten that all this vast undefined period is required for the history of one of the two grades of one of the three branches of the whole Phylum.

Turning now to the brief consideration of the second grade of Arthropods, distinguished from the first grade by the absence of antennæ, the Trilobites are probably the nearest approach to an ancestral form met with in the fossil state. Now that the possession of true antennæ is certain, it is reasonable to suppose that the Trilobites represent an early Class of the Aceratous branch which had not yet become Aceratous. They are thus of the deepest interest in helping us to understand the origin of the antennaless branch, not by the ancestral absence, but by the loss of true antennæ which formerly existed in the group. But the Trilobites did not themselves originate the other Classes, at any

[1] Charles Brongniart—"Recherches pour servir à l'Histoire des Insectes fossiles des temps primaires, précédées d'une Etude sur la nervation des ailes des Insectes." 1894.

rate during Palæozoic times. They represent a large and dominant Class, presenting more of the characters of the common ancestor than the other Classes; but the latter had diverged and had become distinct long before the earliest fossiliferous rocks; for we find well-marked representatives of the Crustacea in Cambrian, and of the Arachnida in Silurian strata. The Trilobites, moreover, appear in the Cambrian with many distinct and very different forms, contained in upwards of forty genera, so that we are clearly very far from the origin of the group.

Of the lower group of Crustacea, the Entomostraca, the Cirripedes are represented by two genera in the Silurian, the Ostracodes by four genera in the Cambrian and over twenty in the Silurian: of these latter two genera, Cythere and Bairdia, continue right through the fossiliferous series and exist at the present day. Remains of Phyllopods are more scanty, but can be traced in the Devonian and Carboniferous rocks. The early appearance of the Cirripedes is of especial interest, inasmuch as the fixed condition of these forms in the mature state is certainly not primitive, and yet, nevertheless, appears in the earliest representatives.

The higher group, the Malacostraca, are represented by many genera of Phyllocarida in the Silurian and Devonian, and two in the Cambrian. These also afford a good example of the imperfection of the record, inasmuch as no traces of the group are to be found between the Carboniferous and our existing fauna in which it is represented by the genus Nebalia. The Phyllocarida are recognised as the ancestors of the higher Malacostraca, and yet these latter already existed—in small numbers, it is true—side by side with the Phyllocarida in the Devonian. The evolution of the one into the other must have been much earlier. Here, as in the Arthropoda, we have evidence of progressive evolution among the highest groups of the Class, as we see in the comparatively late development of the Brachyura as compared with the Macrura. We find no trace of the origin of the Class, or of the larger groups into which it is divided, or, indeed, of the older among the small groupings into families and genera.[1]

Of the Arachnida, although some of the most wonderful examples of persistent types are to be found in this class, but little can be said. Merely to state the bare fact that three kinds of scorpion are found in the Silurian, two Pedipalpi, eight scorpions, and two spiders in the Carboniferous, is sufficient to show that the period computed by geologists must be immensely extended to account for the development of this Class alone, inasmuch as it existed in a highly specialised condition almost at the beginning of the fossiliferous series; while, as regards so extraordinarily complex an animal as a scorpion, nothing apparent in the way of progressive development has happened since. Prof. Lankester has, however, pointed out to me that the Silurian scorpions possessed heavier limbs than those of existing species, and this is a point in favour of their having been aquatic, like their near relation, Limulus. If so, it is probable that they possessed external gills, not yet inverted to form the lung-book. The Merostomata are of course a Palæozoic group, and reach their highest known development at their first appearance in the Silurian; since then they have done nothing but disappear gradually, leaving the single genus Limulus, unmodified since its first appearance in the Trias, to represent them. It is impossible to find clearer evidence of the decline rather than the rise of a group. No progressive development, but a gradual or rapid extinction, and consequent reduction in the number of genera and species, is a summary of the record of the fossiliferous rocks as regards this group and many others, such as the Trilobites, the Brachiopods, and the Nautilidæ. All these groups begin with many forms in the oldest fossiliferous rocks, and three of them have left genera practically unchanged from their first appearance to the present day. What must have been the time required to carry through the vast amount of structural change implied in the origin of these persistent types and the groups to which they belong—a period so extended that the interval between the oldest Palæozoic rocks and the present day supplies no measurable unit?

But I am digressing from the Appendiculate Phylum. We have seen that the fossil record is unusually complete as regards two Classes in each grade of the Arthropod branch, but that these Classes were well developed and flourishing in Palæozoic times. The only evidence of progressive evolution is in the development of the highest orders and families of the Classes. Of the origin of the Classes nothing is told, and we can hardly escape the conclusion that for the development of the Arthropod branches from a common Chætopod-like ancestor, and for the further development of the Classes of each branch, a period many times the length of the fossiliferous series is required, judging from the insignificant amount of development which has taken place during the formation of this series.

It is impossible to consider the other Cœlomate Phyla as I have done the Appendiculata. I can only briefly state the conclusions to which we are led.

As regards the Molluscan Phylum, the evidence is perhaps even stronger than in the Appendiculata. Representatives of the whole of the Classes are, it is believed, found in the Cambrian or Lower Silurian. The Pteropods are generally admitted to be a recent modification of the Gastropods, and yet, if the fossils described in the genera Conularia, Hyolithes, Pterotheca, &c., are true Pteropods, as they are supposed to be, they occur in the Cambrian and Silurian strata, while the group of Gastropods from which they almost certainly arose, the Bullidæ, are not known before the Trias. Furthermore, the forms which are clearly the oldest of the Pteropods—Limacina and Spiriales—are not known before the beginning of the Tertiary Period. Either there is a mistake in the identification of the Palæozoic fossils as Pteropods, or the record is even more incomplete than usual, and the most specialised of all Molluscan groups had been formed before the date of the earliest fossiliferous rocks. If this should hereafter be disproved, there can be no doubt about the early appearance of the Molluscan Classes, and that it is the irony of an incomplete record which places the Cephalopods and Gastropods in the Cambrian and the far more ancestral Chiton no lower than the Silurian. Throughout the fossiliferous series the older families of Gastropods and Lamellibranchs are followed by numerous other families, which were doubtless derived from them; new and higher groups of Cephalopods were developed, and, with the older groups, either persisted until the present time or became extinct. But in all this splitting up of the Classes into groups of not widely different morphological value, there is very little progressive modification, and, taking such changes in such a period as our unit for the determination of the time which was necessary for the origin of the Classes from a form like Chiton, we are led to the same conclusion as that which followed from the consideration of the Appendiculata, viz. that the fossiliferous series would have to be multiplied several times in order to provide it.

Of the Phylum Gephyrea, I will only mention the Brachiopods, which are found in immense profusion in the early Palæozoic rocks and which have occupied the subsequent time in becoming less dominant and important. So far from helping us to clear up the mystery which surrounds the origin of the Class, the earliest forms are quite as specialised as those living now, and, some of them (Lingula Discina) even generically identical. The demand for time to originate the group is quite as grasping as that of the others we have been considering.

All the Classes of Echinoderma, except the Holothurians, which do not possess a structure favourable for fossilisation, are found early in the Palæozoic rocks, and many of them in the Cambrian. Although these early forms are very different from those which succeeded them in the later geological periods, they do not possess a structure which can be recognised as in any way primitive or ancestral. The Echinoderma are the most distinct and separate of all the Cœlomate Phyla, and they were apparently equally distinct and separate at the beginning of the fossiliferous series.

In concluding this imperfect attempt to deal with a very vast subject in a very short time, I will remind you that we were led to conclude that the evolution of the ancestor of each of the higher animal Phyla, probably occupied a very long period, perhaps as long as that required for the evolution which subsequently occurred within the Phylum. But the consideration of the higher Phyla which occur fossil, except the Vertebrata, leads to the irresistible conclusion that the whole period in which the fossiliferous rocks were laid down must be multiplied several times for this later history alone. The period thus obtained requires to be again increased, and perhaps doubled, for the earlier history.

In the preparation of the latter part of this address I have largely consulted Zittel's great work. I wish also to express my thanks to my friend Prof. Lankester, whom I have consulted on many of the details, as well as the general plan which has been adopted.

[1] For an account of the evolution of the Crustacea, see the Presidential Addresses to the Geological Society in 1895 and 1896 by Dr. Henry Woodward.

SECTION G.

MECHANICAL SCIENCE.

OPENING ADDRESS BY SIR DOUGLAS FOX, VICE-PRESIDENT INSTITUTION OF CIVIL ENGINEERS, PRESIDENT OF THE SECTION.

IT is rather over a quarter of a century since the British Association last held its meeting in the hospitable city of Liverpool. The intervening period has been one of unparalleled progress, both generally and locally, in the many branches of knowledge and of practical application covered by Civil and Mechanical Engineering, and therefore rightly coming within the limits for discussion in the important Section of the Association in which we are specially interested.

During these twenty-five years the railway system of the British Isles, which saw one of its earliest developments in this neighbourhood, has extended from 15,376 miles, at a capital cost of 552,680,000*l.*, to 21,174 miles, at a capital cost of 1,001,000,000*l.* The railway system of the United States has more than trebled in the same period, and now represents a total mileage of 181,082, with a capital cost of 11,565,000,000 dollars.

The Forth and Brooklyn, amongst bridges, the Severn and St. Gothard, amongst tunnels, the gigantic works for the water-supply of towns, are some of the larger triumphs of the civil engineer: the substitution of steel for iron for so many purposes, the perfecting of the locomotive, of the marine engine, of hydraulic machinery, of gas and electric plant, those of the mechanical branch of the profession.

The city of Liverpool and its sister town of Birkenhead have witnessed wonderful changes during the period under review. Great and successful efforts have been made to improve the water-gate to the noble estuary, which forms the key to the city's greatness and prosperity; constant additions have been made to the docks, which are by far the finest and most extensive in the world. The docks on the two sides of the river have been amalgamated into one great trust. In order properly to serve the vast and growing passenger and goods traffic of the port, the great railway companies have expended vast sums on the connections with the dock lines and on the provision of station accommodation, and there have been introduced, in order to facilitate intercommunication, the Mersey Railway, crossing under the river, and carrying annually nearly 10 millions of passengers, and the Liverpool Overhead Railway, traversing for six miles the whole line of docks, and already showing a traffic of 7½ millions of passengers per annum. A very complete water-side station connected with the landing-stage has been lately opened by the Dock Board in connection with the London and North-Western Railway. In addition to this, the water-supply from Rivington and Vyrnwy has now been made one of the finest in the world.

The following comparative figures, kindly supplied by Mr. K. Miles Burton, may be of interest:—

	1871 (estimated).	1895 (estimated).
Population of Liverpool ...	493,405	641,000
Population of Birkenhead ...	65,971	109,000
	Acres.	Acres.
Area of docks, Liverpool, about	236	362½
Area of docks, Birkenhead, about	147	160
	383	552½
Number of steamers using the port	7,448	18,429
Average tonnage of six largest vessels entering the port ...	2,890	6,822

The following figures show the importance of the local railway traffic:—

Number of passenger stations within the boroughs ...	—	58
Number of goods stations ...	—	50
Number of passengers crossing the Mersey in the twelve months (Woodside Ferry)	—	7,143,088
Number of passengers crossing the Mersey in the twelve months (Mersey Railway)	—	6,976,299

To the hydraulic engineer there are few rivers of more interest, and presenting more complicated problems, than the Mersey and its neighbours, the Dee and the Ribble. They all possess vast areas of sand covered at high water, but laid dry as the tide falls, and in each case the maintenance of equilibrium between the silting and scouring forces is of the greatest importance to the welfare of the trading communities upon their banks. The enclosure of portions of the areas of the respective estuaries for the purposes of the reclamation of land, or for railway or canal embankments, may thus have far-reaching effects, diminishing the volume of the tidal flow and reducing the height of tide in the upper reaches of the rivers. Some idea of the magnitude of these considerations may be derived from the fact that a spring tide in the Mersey brings in through the narrows between Birkenhead and Liverpool 710 millions of cubic yards of water to form a scouring force upon the ebb. The tidal water is heavily laden with silt, which is deposited in the docks, and, at slack water, upon the sandbanks. The former is removed by dredging, and amounts to some 1,100,000 cubic yards per annum; the latter is gradually fretted down into the channels and carried out to sea before the ebb. Whilst a considerable portion of the narrows is kept scoured, in some places right down to the sandstone rock, there is a tendency, on the Liverpool side, near the landing-stage, to silt up, a difficulty counteracted, to some extent, by the extensive sluicing arrangements introduced by Mr. George Fosbery Lyster, the engineer of the Mersey Docks and Harbour Board.

Very extensive and interesting operations have been carried on by the Board in connection with the bar at the mouth of the river. Dredgers specially designed for the purpose have been employed for some six years, with the result that 15,142,600 tons of sand and other dredged matter have been removed, and the available depth of water at low-water increased from 11 to 24 feet in a channel 1500 feet in width.

Those who have made the transatlantic passage in former years can more readily appreciate the very great advantage accruing from this great improvement.

Formerly vessels arriving off the port on a low tide had to wait for some hours for the water-level to rise sufficiently to enable them to cross the bar; the result of a large vessel lying outside, rolling in the trough of the sea with her engines stopped, was that not infrequently this proved to be the worst part of the voyage between New York and Liverpool, and passengers who had escaped the malady of sea-sickness throughout the voyage were driven to their cabins and berths within three or four hours of landing.

Owing to the very successful dredging operations, ships of largest size can now enter or depart from the Mersey at any state of the tide, and they are also able to run alongside the landing-stage without the intervention of a tender.

Such vessels as the *Teutonic* or *Majestic*, of nearly 10,000 registered tonnage, 566 feet in length, 57 feet wide, and 37 feet deep; or the still larger vessels, the *Campania* or *Lucania*, of nearly 13,000 tons register, 601 feet in length, 65 feet in width, and 38 feet in depth, can be seen, on mail days, lying alongside.

Whilst the estuary of the Mersey presents a narrow entrance with a wide internal estuary, the Dee, owing to extensive reclamation of land in the upper reaches, has a wide external estuary leading to an embanked river of very limited width, up which the tide rushes with great velocity laden with silt, rising in some two hours, then, during a short time of slack water, depositing the silt, which is not removed by the ebb-tide, spread over some ten hours, and therefore having comparatively little velocity. In this case, also, the outer estuary shows a great tendency to silt up beyond the reach of any but the highest spring tides.

The reclamation of the Ribble has not yet proceeded so far as to so seriously affect the general conditions of the estuary; but here, also, there is a constant tendency in the channels to shift, and the erosion which takes place when a high tide and wind combine is very remarkable.

A most important improvement was introduced in 1886, by Mr. G. F. Lyster, when it was decided to raise the water-level in certain of the docks by pumping, the wharves being heightened in proportion, and half-tide basins, or locks, made use of to compensate for the difference of level.

The area of the docks so treated in Liverpool is 78 acres, whilst at Birkenhead the whole area of the docks on that side of the river, amounting to 160 acres, is so raised.

The hydraulic power used in the docks is very large, the indicated horse-power of the engines amounting to 1673 in the case of Liverpool, and 874 in that of Birkenhead; whilst the Hydraulic Power Company are supplying some 1000 h.p. to railways and private firms.

The direct-acting hydraulic lifts of the Mersey Railway have now been at work for ten years, and through these, at St. James's Station, no less than 75,000,000 to 80,000,000 of passengers have passed with regularity and safety.

It is remarkable that, whilst Great Britain led the van in the introduction of steam locomotion, she has lagged in the rear as regards electric and other mechanical traction. This arose in the first instance from mistaken legislation, which strangled electrical enterprise, which is still much hampered by the reluctance of public authorities to permit the introduction of the necessary poles and wires into towns.

At the date of the latest published returns there were at work in the United States no less than 12,133 miles of electric, in addition to 599 miles of cable, tramway. Hardly a large village but has its installation, and vast have been the advantages derived from these facilities. In Brooklyn one company alone owns and works 260 miles of overhead trolley lines. With the exception of some small tramways at Portrush, Brighton, Blackpool, South Staffordshire, Hartlepool, &c., the only examples in this country of serious attempts to apply electro-motive force to the carriage of passengers are the City and South London Railway and the Liverpool Overhead Railway, the latter being the latest constructed, and having, therefore, benefited by the experience gained upon the London line.

This railway is over six miles long, a double line of the normal, or 4 ft. $8\frac{1}{2}$ in. gauge, running on an iron viaduct for the whole length of the docks; the installation is placed for convenience of coal supply about one-third of the distance from the northern end. Particulars of this interesting work will be placed before the Section, but suffice it to say that a train service of three minutes each way is readily maintained, with trains carrying 112 passengers each, at an average speed of twelve miles per hour, including stoppages at fourteen intermediate stations. During the last year, as before stated, $7\frac{1}{2}$ million passengers were carried, the cost of traction per train mile being 3·4*d.*

The Hartlepool Tramway is proving successful, overhead trollies and electric traction having taken the place of a horse tramroad, which was a failure from a traffic point of view.

Careful researches are being prosecuted, and experiments made, with the intention of reducing the excessive weight of storage batteries. If this can be effected, they should prove very efficient auxiliaries, especially where, in passing through towns, underground conductors are dangerous, and overhead wires objectionable.

In connection with electric traction, it is very important to reduce, if possible, the initial force required for starting from rest. Whether this will be best attained by the improvement of bearings and their better lubrication, or by the storage, for starting purposes, of a portion at least of the force absorbed by the brakes, remains to be seen, but it is a fruitful field for research and experiment.

In the United States there is a very general and rapid displacement of the cable tramways by the overhead wire electric system. The latter has many opponents, owing, probably, to causes which are preventible.

Many accidents were caused by the adoption of very high tension currents, which, on the breakage of a wire, were uncontrollable, producing lamentable results.

The overhead wires were placed in the middle of the street, causing interference with the passage of fire-escapes.

The speed of the cars was excessive, resulting in many persons being run over.

The cable system, therefore, found many advocates, but the result of experience is in favour of electrical traction under proper safeguards.

The cable system can only compete with the electric system when a three-minute or quicker service is possible, or, say, when the receipts average £20 per mile per day; it is impossible to make up lost time in running, and the cars cannot be "backed." If anything goes wrong with the cable the whole of the traffic is disorganised. The cost of installation is much greater than in the case of electricity, and extensions are difficult.

On the other hand, electricity lends itself to the demands of a growing district, and extensions are easily effected; it satisfies more easily the growing demands on the part of the public for luxury in service and car appointment. It is less expensive in installation, and works with greater economy. By placing the wire at the side of the street, and using a current of low voltage, the objections are greatly minimised, and the cars are much more easily controlled and manipulated. In cases of breakdown these are limited to the half-mile section, and do not completely disorganise the service. Electric cars have been worked successfully on gradients of 1 in 7.

The conduit slot system can be adopted with good results, provided care is taken in the design of the conduit, and allowance made for ample depth and clearance; a width of $\frac{3}{4}$-inch is now proved to be sufficient. Where, however, there are frequent turnouts, junctions, and intersecting lines, the difficulties are great, and the cost excessive.

The following figures represent the cost of a tramway, on this system, in America.

Cost of track and conduit	£5600	(per mile of
Insulator, boxer, and double conductor .	480	single track)
Asphalte paving on 6 inches of concrete to 2 feet outside double track) . .	1500	,,
	£7580	

Complete cost of operating 4 miles of double track for 24 hours per day with $2\frac{1}{2}$ minute service, 4·55*d.* per train mile (exclusive of interest, taxes, &c.).

One train consists of one motor car and one trailer.

The trains make a round trip of eight miles in one hour, with three minutes lay-off at each end.

The cost of keeping the slot clean comes to about 40*l.* per quarter, and the repairs to each plough conductor about 50*s.* per quarter.

Attempts have been made to obviate the necessity of the slot by what is known as the closed conduit; but at present the results are not encouraging.

The following figures will help to convey to the mind the great development which is taking place in America, as regards the earnings upon lines electrically equipped. They are derived from the Report of the State Board of Railroad Commissioners for Massachusetts.

	1888.	1894.	Increase per cent.
Net earnings per passenger carried ...	·48	·78	62·5
Net earning per car mile	2·78	4·83	73·56
Net earning per mile of road	£484	£762	57

In addition to the application of electricity for illuminating purposes, and for the driving of tram-cars and railways, it has also been applied successfully to the driving of machinery, cranes, lifts, tools, pumps, &c., in large factories and works. This has proved of the greatest convenience, abolishing as it does the shafting of factories, and applying to each machine the necessary power by its own separate motor; the economy resulting from this can hardly be over-estimated.

It is also successfully employed in the refining of copper, and in the manufacture of phosphorus, aluminium, and other metals, which, before its application, were beyond the reach of commercial application.

The extent of its development of chemical purposes in the future no one can foresee.

It is hardly necessary to call attention to the successful manner in which the Falls of Niagara, and the large Falls of Switzerland, and elsewhere, are being harnessed and controlled for the use of man, and in which horse-power by thousands is being obtained.

At Niagara, single units of electrical plant are installed equal to about 5000 horse-power output. The units are destined to be utilised for any of the purposes previously suggested, and it is computed that one horse-power can be obtained from the river, and sold for the entire year day and night continuously, for the sum of 3*l.* 2*s.* 6*d.* per annum.

Electric head lights are being adopted for locomotives in the United States.

The use of compressed air and compressed gas for tractive purposes is at present in an experimental stage in this country. The latter is claimed to be the cheapest for tramway purposes, the figures given being—

Single horse cars	$5\frac{3}{4}$*d.*
Electrical cars, with overhead wires	$4\frac{1}{4}$*d.*
Gas cars	$3\frac{1}{4}$*d.*

Combination steam and electric locomotives, gazoline, compressed air, and hot-water motors are all being tried in the United States, but definitive results are not yet published.

The first electric locomotive practically applied to hauling heavy trains was put into service on the Baltimore and Ohio Railway in 1895 to conduct the traffic through the Belt Line Tunnel.

It is stated that, not only was the guaranteed speed of 30 miles per hour attained, but, with the locomotive running light, it reached double that speed.

On the gradient of 8 per cent. a composite train of forty-four cars, loaded with coal and lumber, and three ordinary locomotives—weighing altogether over 1800 tons—was started easily and gradually to a speed of 12 miles an hour without slipping a wheel. The voltage was 625. The current recorded, was at starting, about 2200 ampères, and, when the train was up to speed, it settled down to about 1800 ampères. The drawbar pull was about 63,000 lbs.

The actual working expense of this locomotive is stated to be about the same as for an ordinary goods locomotive—viz. 23 cents per engine mile.

The rapid extension of tunnel construction for railway purposes, both in towns and elsewhere, is one of the remarkable features of the period under review, and has been greatly assisted by the use of shields, with and without compressed air. This brings into considerable importance the question of mechanical ventilation. Amongst English tunnels, ventilation by fan has been applied to those under the Severn and the Mersey. The machinery for the latter is, probably, the most complete and most scientific application up to the present time.

There are five ventilating fans, two of which are 40 feet in diameter, and 12 feet wide on the blades; two of 30 feet, and 10 feet wide; and one quick-running fan of 16 feet in diameter, all of which were ably installed by Messrs. Walker Brothers of Wigan. They are arranged, when in full work, to throw 800,000 cubic feet of air per minute, and to empty the tunnel between Woodside and St. James's Street in eight minutes; but, unfortunately, it is found necessary, for financial reasons, not to work the machinery to its full capacity.

The intended extension of electrical underground railways will render it necessary for those still employing steam traction either to ventilate by machinery or to substitute electro-motive force.

Great improvements have been lately made in the details of mechanical ventilators, especially by the introduction of anti-vibration shutters, and the driving by belts or ropes instead of direct from the engine. The duties now usually required for mining purposes are about 300,000 cubic feet of air per minute with a water-gauge of about 4 inches; but one installation is in hand for 500,000 cubic feet of air per minute, with a water-gauge of 6 inches. Water-gauge up to 10 inches can now be obtained with fans of 15 feet diameter only.

An interesting installation has been made at the Pracchia Tunnel on the Florence and Bologna Railway.

The length of the tunnel is 1900 metres, or about 2060 yards; it is for a single line, and is on a gradient of 1 in 40. When the wind was blowing in at the lower end, the steam and smoke of an ascending train travelled concurrently with the train, thus producing a state of affairs almost unimaginable except to those engaged in working the traffic.

Owing to the height of the Apennines above the tunnel, ventilating shafts are impracticable; but it occurred to Signor Saccardo that, by blowing air by means of a fan into the mouth of the tunnel, through the annular space which exists between the inside of the tunnel arch and the outside of the traffic gauge, a sufficient current might be produced to greatly ameliorate the state of things.

The results have been most satisfactory, the tunnel, which was formerly almost dangerous, under certain conditions of weather, being now kept cool and fresh, with but a small expenditure of power.

In an age when, fortunately, more attention is paid than formerly to the well-being of the men, the precautions necessary to be observed in driving long tunnels, and especially in the use of compressed air, are receiving the consideration of engineers. In the case of the intended Simplon Tunnel, which will pierce the Alps at a point requiring a length of no less than 12½ miles, a foreign commission of engineers was entrusted by the Federal Government of Switzerland with an investigation of this amongst other questions.

During the construction of the St. Gothard Tunnel, which is about ten miles in length, the difficulties encountered were, of necessity, very great; the question of ventilation was not fully understood, nor was sanitary science sufficiently advanced to induce those engaged in the work to give it much attention. The results were lamentable, upwards of 600 men having lost their lives, chiefly from an insidious internal malady not then understood. But the great financial success of this international tunnel has been so marked as to justify the proposed construction of a still longer tunnel under the Simplon.

The arrangements which are to be adopted for securing the health of the *employés* are admirable, and will surely not only result in reducing the death-rate to a minimum, but also tend to shorten the time necessary for the execution of the undertaking to one-half.

The quantity of air to be forced into the workings will be twenty times greater than in previous works. Special arrangements are devised for reducing the temperature of the air by many degrees, suitable houses are to be provided for the men, with excellent arrangements for enabling them to change their mining clothes, wet with the water of the tunnel, before coming in contact with the Alpine cold; every man will have a bath on leaving; his wet clothes will be taken care of by a custodian, and dried ready for his return to work; suitable meals of wholesome food will be provided, and he will be compelled to rest for half-an hour on emerging from the tunnel, in pleasant rooms furnished with books and papers. This may appear to some as excessive care; but kind and humane treatment of men results, not only in benefit to them, but also in substantial gain to those employing them, and the endeavour of our own authorities, and of Parliament, to secure for our own workpeople the necessary protection for their lives and limbs in carrying out hazardous trades and employments, is worthy of admiration.

The great improvements in sub-aqueous tunnelling can be clearly recognised from the fact that the Thames Tunnel cost 1150*l.* per lineal yard, whilst the Blackwall Tunnel, consisting of iron lined with concrete, and of twenty-five feet internal diameter, has, by means of Greathead's shield and grouting machine, been driven from shaft to shaft a distance of 754 yards for 375*l.* per yard.

Tunnels have now been successfully constructed through the most difficult strata, such as water-bearing silt, sand, and gravel, and, by the use of grouting under pressure, subsidence can almost entirely be avoided, thus rendering the piercing of the substrata of towns, underneath property without damaging it, a simple operation; and opening up to practical consideration many most important lines of communication hitherto considered out of the question.

On the other hand, very little improvement has taken place in the mode of constructing tunnels in ordinary ground, since the early days of railways. The engineers and contractors of those days adopted systems of timbering and construction which have not been surpassed. The modern engineer is, however, greatly assisted by the possibility of using Brindle bricks of great strength to resist pressure, combined with quick-setting Portland cement, by the great improvements which have taken place in pumping machinery, and by the use of the electric light during construction.

A question which is forcing itself upon the somewhat unwilling attention of our great railway companies, in consequence of the continual great increase of the population of our cities, is the pressing necessity for a substantial increase in the size of the terminal stations in the great centres of population.

Many of our large terminal stations are not of sufficient capacity to be worked properly, either with regard to the welfare of the staff, or to the convenience of the travelling public.

Speak to station-masters and inspectors on duty, when the holiday season is on, and they will tell you of the great physical strain that is produced upon them and their subordinates, in endeavouring to cope with the difficulty.

This, if nothing else, is a justification for the enterprise of the Manchester, Sheffield and Lincolnshire Railway Company in providing an entirely new terminus for London.

It is thirty years since the last, that of St. Pancras, was added, and during that period the population of London has increased by no less than two millions.

The discussion, both in and out of Parliament, of the proposals for light railways has developed a considerable amount of interest in the question. Experience only can prove whether they will fulfil the popular expectations. If the intended branch lines are to be of the standard gauge, with such gradients, and curves as

will render them suitable for the ordinary rolling-stock, they will, in many cases, not be constructed at such low mileage costs as to be likely to be remunerative at rates that would attract agricultural traffic. The public roads of this country (very different from the wide and level military roads of Northern Italy and other parts of the continent) do not usually present facilities for their utilisation, and, once admitted, the necessity for expropriating private property, the time-honoured questions of frontage severances and interference with amenities will force their way to the front, fencing will be necessary, and, even if level crossings be allowed at public roads, special precautions will have to be taken.

Much must then depend upon the regulations insisted upon by the Board of Trade. If, in consideration of a reduction in speed, relaxation of existing safeguards are permitted, much may, no doubt, be effected by way of feeders to existing main lines.

If, on the other hand, the branches are of narrower gauge, separate equipment will be necessary, and transhipment at junctions will involve both expense and delay. It is very doubtful whether the British farmer would benefit much from short railways of other than standard gauge. He must keep horses for other purposes, and he will probably still prefer to utilise them for carting his produce to the nearest railway station of the main line, or to the market town.

The powers granted by the Light Railways Act, in the hands of the able Commissioners appointed under the Act, cannot, however, fail to be a public boon.

Special Acts of Parliament will be unnecessary, facilities will be granted, procedure simplified, some Government aid rendered, and probably the heavy burden of a Parliamentary deposit will be removed.

It would seem quite probable, that motor cars may offer one practical solution of the problem how best to place the farms of the country in commercial touch with the trunk railways, seaports, and market towns. They could use existing roads, could run to the farmyard or field, and receive or deliver produce at first hand.

Such means of locomotion were frequently proposed towards the end of the last century, and in the early part of the present one, and it was not until the year 1840, that the victory of the railway over steam upon common roads was assured, the tractive force required being then shown to be relatively as 1 to 7.

The passing of the Act of 1896, superseding those of 1861 and 1865, will undoubtedly mark the commencement of a new era in mechanical road traction. The cars, at present constructed chiefly by German and French engineers, are certainly of crude design, and leave much to be desired. They are ugly in appearance, noisy, difficult to steer, and vibrate very much with the revolutions of their engines, rising as they do to 400 per minute; those driven by oil give out offensive odours, and cannot be readily started, so that the engine runs on during short stops. There would seem to be arising here an even more important opening for the skill of our mechanical engineers than in the case of bicycles, in which wonderful industry the early steps appear also to have been foreign.

It is claimed for a motor car that it costs no more than carriage, horse, and harness, that the repairs are about the same, and that, whilst a horse, travelling 20 miles per day, represents for fodder a cost of *2d.* per mile, a motor car of $2\frac{1}{2}$ horse-power will run the same distance at $\frac{1}{2}$*d.* per mile.

The highway authorities should certainly welcome the new comer, for it is estimated that two-thirds of the present wear and tear of roads is caused by horses, and one-third only by wheels.

Perhaps no invention has had so widespreading an influence on the construction of railways as the adoption of the Bessemer process for the manufacture of steel rails. This has substituted a homogeneous crystalline structure, of great strength and uniformity, for the iron rails of former years, built up by bundles of bars, and therefore liable to lamination and defective welds. The price has been reduced from the 13*l.* per ton, which iron rails once reached, to 3*l.* 15*s.* as a minimum for steel. There are, however, not infrequently occurring, in the experience of railway companies, the cracking, and even fracture of steel rails, and the Government has lately appointed a Board of Trade Committee for the investigation, incidentally of this subject, but specially of the important question of the effect of fatigue upon the crystallisation, structure, and strength of the rail. Experience proves, at any rate, that it is of great importance to remove an ample length of crop end, as fractures more frequently take place near the ends, aided by the weakening caused by bolt holes. Frequent examination by tapping, as in the case of tyres, seems, at present, the most effective safeguard.

It is open to serious question, whether the great rigidity of the permanent way of the leading railways of this country is an advantage. Certainly the noise is very great, more so than in other countries, and this points to severe shocks, heavy wear and tear of rails and tyres, and—especially when two heavy locomotives are run with the same train—liability to fracture. Whilst the tendency in this country, and in the United States, has been to gradually increase the weight of rails from 40 lbs. up to 100 lbs. per lineal yard, there are engineers who think that to decrease the rigidity of rail and fishplate, and weight of chair, and to increase the sleepers, so as to arrive as nearly as possible at a continuous bearing, would result in softness and smoothness of running.

The average and maximum speeds now attained by express trains would appear to have reached the limit of safety, at any rate under the existing conditions of junctions, cross-over roads, and other interferences with the continuity of the rail. If higher speeds are to be sought, it would seem to be necessary to have isolated trunk lines, specially arranged in all their details, free from sharp curve and severe gradient, and probably worked electrically, although a speed of 100 miles per hour is claimed to have been reached by a steam locomotive in the United States.

The grain trade of the port of Liverpool has assumed very large proportions, and the system of storage in large silos has been adopted, with great advantage, both as regards capital, outlay, and the cost of working, per ton of grain.

The Liverpool Grain Storage Warehouses at Bootle will be open to members of the Association, and there can be seen the latest development of the mechanical unloading, storing and distribution of grain in bulk; the capacity is large, being—

Warehouse No. 1,	56,000 tons	or 4,240,000 bushels;
,, ,, 2,	30,000 ,,	
Quay Stores	20,000 ,,	

thus constituting this granary as one of the largest, if not the largest, in the world.

The question of the pressure of grain is a very difficult one, and, in constructing the brick silos, which are 12 feet across at the top, by nearly 80 feet in depth, large allowance has been made both for ordinary pressure, and for possible swelling of the grain.

The grain is unloaded by elevators, and then transported on bands, the result being its cooling and cleansing, as well as its storage and distribution.

The question of the early adoption in England of the metric system is of importance not only to the engineering profession, but also to the country at large. The recommendation of the recent Royal Commission, appointed for the consideration of the subject, was, that it should be taught at once in all schools, and that, in two years' time, its adoption should be compulsory; but it is much to be regretted that, up to the present time, nothing has been done.

The slight and temporary inconvenience of having to learn the system is of no moment compared to the great assistance it would prove to the commercial and trading world; the simplification of calculations and of accounts would be hailed with delight by all so soon as they realised the advantages. England is suffering greatly in her trade with the continent for want of it.

Our foreign customers, who have now used it for many years, will not tolerate the inconvenience of the endless variety of weights and measures in use in England, and they consequently purchase their goods, to a great extent, from Germany, rather than use our antiquated English system. It is no exaggeration to say that, with their knowledge of the metric system, they regard ours as completely obsolete and unworkable, just in the same way as we should were we to buy our corn, our wine, our steel and iron, by the hin, the ephah, or the homer, or to compute our measurements by cubit, stadium, or parasang.

It behoves all who desire to see England regain her trade to use all their influence in favour of the adoption of this system, as its absence is, doubtless, one of the contributory causes for the loss that has taken, and is taking, place.

An important argument in favour of the metric system or

weights and measures is that it is adopted all over the civilised world by physicists and chemists; and it may be stated with confidence, that the present international character of these sciences is largely due to this.

It is interesting also to notice, that the metric system is being gradually introduced into other branches of science. Anthropometric measurements made by the Committees of the British Association in this country and in Canada are invariably given in metres, and a comparison with measurements made in other countries can be at once made.

The period of twenty-five years under review has indeed witnessed great advances, both in scientific knowledge and practical application. This progress has led to powerful yet peaceful competition between the leading nations. Both from among our cousins of the United States, and from our nearer neighbours of Europe, have we, at this meeting, the pleasure of welcoming most respected representatives. But their presence, and the knowledge of the great discoveries made, and colossal works carried out, by them and their brother scientific men and engineers, must make us of Great Britain face with increased earnestness the problem of maintaining our national position, at any rate, in the forefront of all that tends towards the "utilisation of the great sources of power in nature for the use and convenience of man." Those English engineers who have been brought in contact with engineering thought and action in America and abroad have been impressed with the thoroughness of much of the work, the great power of organisation, and the careful reliance upon scientific principles constantly kept in view, and upon chemical and mechanical experiments, carried out often upon a much more elaborate scale than in this country. This is not the place from which to discuss the questions of bounties and tariffs, which have rendered possible powerful competition for the supply of machinery and railway plant from the continent to our own colonies; but there is certainly need for advance all along the line of mechanical science and practice, if we are to hold our own—need especially to study the mechanical requirements of the world, ever widening and advancing, and to be ready to meet them, by inventive faculty first, but also by rigid adherence to sound principles of construction, to the use of materials and workmanship of the highest class, to simplicity of design and detail, and to careful adaptation of our productions to the special circumstances of the various markets.

It is impossible to forecast in what direction the great advances since 1871 will be equalled and exceeded in the coming quarter of a century. Progress there will and must be, probably in increased ratio; and some, at the end of that period, may be able to look back upon our gathering here in Liverpool in 1896 as dealing with subjects then long since left behind in the race towards perfection.

The mechanical engineer may fairly hope for still greater results in the perfection of machinery, the reduction of friction, the economical use of fuel, the substitution of oil for coal as fuel in many cases, and the mechanical treatment of many processes still dependent upon the human hand.

The electrical engineer (hampered as he has been in this country by unwise and retrograde legislation) may surely look forward to a wonderful expansion in the use of that mysterious force, which he has already learned so wonderfully to control, especially in the direction of traction.

The civil engineer has still great channels to bridge or tunnel, vast communities to supply with water and illuminating power, and (most probably with the assistance of the electrician) far higher speeds of locomotion to attain. He has before him vast and ever-increasing problems for the sanitary benefit of the world, and it will be for him to deal from time to time with the amazing internal traffic of great cities. China lies before him, Japan welcomes all advance, and Africa is great with opportunities for the coming engineers.

Let us see to it, then, that our rising engineers are carefully educated and prepared for these responsibilities of the future, and that our scientific brethren may be ever ready to open up for them by their researches fresh vistas of possibilities, fresh discoveries of those wonderful powers and facts of nature which man to all time will never exhaust.

The Mechanical Section of the British Association has done good work in this direction in the past, and we may look forward with confidence to our younger brethren to maintain these traditions in the future.

THE IRON AND STEEL INSTITUTE.

THE Iron and Steel Institute, probably the most cosmopolitan of all our technical societies, has always been noted for taking its members far afield during the annual autumn excursions. The United States—from far north to the extreme south—Austria, Hungary, Germany, France, and Belgium have been among the countries visited, and now Spain may be included in the list. A very novel and somewhat ambitious programme had been arranged by the Executive for the 1896 meeting. It has long been thought desirable that members of the Institute should pay a formal visit to the great source of supply for the steel-workers' raw material situated in Northern Spain. It is from the Bilbao district that the greater part of the iron ore used by British steel-makers is obtained. What the modern steel trade of this country would have been had not the wonderful deposits of non-phosphoric ore of the Peninsula existed it is difficult to realise, but we may be sure that the industry would not have flourished in the way it has. We have, it is true, a limited and partial supply of hæmatite ore in this country; but it would not nearly have sufficed to satisfy the demands of the trade. The acid process of steel-making requires ores free from phosphorus, and though the basic process has been introduced with a view to eliminating phosphorus during the course of manufacture, it cannot be said to have rendered us independent of purer ores.

Nature seems to have designed the hills of Northern Spain especially for the use of the steel-maker. Happily for England, the communication between our country and Spain is of a very direct nature, and across the element which is peculiarly our own, the open sea. Next to having these pure rich ores within our own borders, they could hardly be placed more advantageously than they now are. Spain has not been in the past ambitious to institute a steel-making industry. She has been content to sell the valuable raw material to countries with a more advanced manufacturing organisation. A new spirit, however, has arisen of late, and the somewhat sorely-pressed steel-maker of to-day finds the prospect of another rival springing up at the seat of supply. That, however, is more of the future than the present, for the steel works of Spain now in operation are of comparatively small extent.

The iron mines of Northern Spain are not mines at all in the proper acceptation of the term, for they are open workings, in fact vast diggings or quarries. The mountains themselves are just heaps of iron ore, covered naturally with but a thin layer of earth. This is removed, and it only remains to break up the ore and load it into fitting receptacles, when it is conveyed down to the water's edge by its own gravity. It is difficult to conceive anything more favourable for the purposes of transport. Self-propulsion to the ship's hold, and then the cheapest of all artificial methods of carriage to the home port. Fortunately for us, in the struggle for the word's steel market, our coast-line is more accessible from Spain than that of our great rival, Germany. The Pyrenees offer a barrier to land carriage even if the French railways would frame rates that would allow competition with those wonderfully economical cargo boats, which are one of the greatest triumphs of our engineering industry. There are, however, compensations for our great competitor even in this. A patient and ingenious people, such as the Germans, finding they are blocked in one direction will try other measures. In the manufacture of acid steel Germany laboured under a disadvantage, for the reasons stated, but this led her steel-makers to put forth great efforts to perfect the basic process, by which they could utilise their own supply of native ore, too phosphoric for the manufacture of acid steel. Their labours have been crowned with almost unexampled success, for the development of the basic steel industry in Germany is one of the most creditable achievements in the history of industrial progress. It is true that the best steel is produced from non-phosphoric ores, but the German makers can manufacture excellent steel castings at a low price, and though these may not be equal to the best acid steel, they are commercially successful. After all steel-making is a trade, not simply a competition like prize-winning at an exhibition.

We have been led somewhat astray from our immediate subject by the economic problem suggested by the Bilbao trip of the Iron and Steel Institute, and will now return to our text. The Council, knowing the insufficiency of hotel accommodation for so large a number of persons

as was expected to take part in the expedition, made arrangements to charter a steamer which should not only convey the party from England to Spain and back, but should serve as a floating hotel during the whole time. It may be said that in no other way would the expedition have been possible. The large Orient liner, *Ormuz*, was therefore engaged for the purpose. This vessel left Tilbury on Saturday the 29th ult., and arrived off the mouth of the river Nervion about midday on the Monday following. Of the run down Channel and across the Bay of Biscay it is unnecessary to say much; some enjoyed it, some did not.

On the arrival of the ship the Reception Committee came off in three steamers and welcomed their guests to Spain. This was the first expression of that kindness and hospitality of which the members of the Institute received so many proofs throughout the visit. The Reception Committee, having re-embarked members, were transferred to small steamers and taken for a trip up the Nervion to inspect the extensive engineering works that have converted this once small and unimportant stream into a commodious port. Although the depth of water over the bar is not sufficient to admit the largest type of ocean liners, such as the *Ormuz*, yet it is enough for the class of ore-carrying ships now engaged in the trade. Last year one vessel, drawing 22 feet 10 inches of water, and carrying 5380 tons of ore, sailed from the port. Bilbao itself lies some distance inland, twelve miles or so up the river Nervion, but the loading stations of the port are nearer the sea. At the present time two breakwaters have been commenced. By means of these a considerable part of the Concha, or Bay of Bilbao, will be enclosed, and thus form a safe anchorage for the largest ships. At the mouth of the Nervion is situated the town of Portugalete. Here the two banks of the river are connected by a somewhat novel form of bridge, or, as it might perhaps be better described, by an aërial ferry. It is necessary at this point to give sufficient height for the masts of ships to pass under, and this would necessitate, where ordinary conditions followed, either a swing bridge or a structure which would be at a height involving steep and long gradients for its approach. Both these plans would have been expensive and inconvenient. The scheme adopted was to erect a high gantry supported by towers on either bank. Suspended from this gantry by wire ropes is a large cage, capable of carrying 30 tons live load. There is a trolley which travels on a roller path on the gantry, and to which the wire ropes holding the cage are attached. A 25 horse-power engine is used for traversing the trolley, which of course carries the cage with it from side to side, and thus transports the passengers across the river. The cage is entered at the ground level, and travels at a safe height above the water. The span is 531 feet, and the roller path is 147 feet above high-water spring-tides. The cost of the structure was no more than £20,000.

On the following day, Tuesday, September 1, members were conveyed ashore from the *Ormuz* in steam tenders, and were then taken to Bilbao by train. Sittings for the reading and discussion of papers had been arranged for this and the next (Wednesday) morning. The following is a list of the papers read:

(1) "On the Spanish Iron Industry," by Don Pablo de Alzola (Bilbao).

(2) "On the Estimation of Sulphur in Iron Ores," by R. W. Atkinson and A. J. Atkinson (Cardiff).

(3) "On a New Water-cooled Hot-blast Valve," by William Colquhoun (Liverpool).

(4) "On the Present Position of the Iron Ore Industries of Biscay and Santander," by William Gill (Bilbao).

(5) "On the Manganese Ore Deposits of Northern Spain," by Jeremiah Head.

(6) "On Sand on Pig-Iron and its Avoidance," by H. D. Hibbard (Highbridge, New Jersey, U.S.A.).

(7) "On the Missing Carbon in Steel," by T. W. Hogg (Newburn Steel Works).

(8) "A Note on the Presence of Fixed Nitrogen in Steel," by F. W. Harbord and T. Twynam.

(9) "Further Notes on the Walrand Process," by G. J. Snelus, F.R.S., Vice-President.

(10) "On the Roasting of Iron Ores with a View to their Magnetic Concentration," by Prof. H. Wedding, Bessemer Gold Medallist (Berlin).

The first paper taken, that of Don Pablo de Alzola, gave an account (necessarily brief) of the condition of the iron and steel industry of Spain, referring by way of preface to the ore deposits of the country. There are two important districts, Biscay (of which Bilbao is the centre) and that of Asturias. In the latter district there are coalfields, but the ores are less rich than in Biscay. The total Spanish output of iron ore in last year was 5,514,399 tons. One-tenth of this was smelted in Spain. It will be interesting here to repeat a passage from the elder Pliny, which Don Pablo quotes: "In the part of the Cantabrian coast which is washed by the ocean, there rises a high and steep mountain which, marvellous to relate, is composed entirely of iron." It will be therefore seen that the iron ore of Northern Spain was known in the first century of the Christian era; and there are, we learn from the paper, records of ore being shipped from the Bilbao River as far back as the tenth century. The Spanish ore was, however, earlier worked on the spot, and the fame of Spanish iron of the Middle Ages was world-renowned, as every metallurgical student knows. The industry has continued from the fifteenth century down to our own time; the well-organised, if limited number, of iron and steel works at present existing thus being the modern representatives of a very ancient industry.

In the latter part of his paper, Don Pablo enters upon the politico-economic aspect of the Spanish iron trade. He assumes that the deposits of rich non-phosphoric ores of the district are becoming exhausted by the vast exports now taking place, and regrets that foreigners should be allowed to carry off the natural wealth of the country, and that foreign capital should not be directed to the permanent good of the nation, rather than conferring fugitive and ephemeral prosperity upon a district; in other words, the author asks for protection for native industry. Here are the facts upon which he bases his demand:—

"From two tons of ore valued at 18 pesetas (30 pesetas equal one pound sterling roughly) there is obtained one ton of pig iron, the price of which is 64 pesetas. If this is converted into rails, it sells at 140 pesetas. Rolled into steel plates, it increases in price to 210 pesetas; forged into axles, &c., it increases to 700 pesetas; and if it is converted into engines and boilers, it increases to 1200 pesetas per ton, and to 1500 in locomotives and marine engines."

Whether Spain can be converted into a vast factory for the manufacture of steel rails, plates, axles, engines, boilers, and locomotives "by stimulating in Biscay the manufacture of steel, and by imposing some restrictions on the export of ores," is a subject upon which we need not here enter, as, fortunately, the matter was not discussed at the meeting after the reading of the paper.

Mr. Gill's contribution was next taken. It was really a volume rather than a paper, and taken in conjunction with a former contribution he made to the *Transactions* of the Institute in 1882, may be looked upon as a standard work of reference upon the iron industry of Northern Spain. Mr. Gill is the chief engineer and manager of the Oconera Iron Ore Company, the largest establishment of its kind in the world. He was also one of the secretaries of the Reception Committee, and in that capacity earned the gratitude of every member of the expedition by the unceasing care he bestowed upon their welfare. It would be a hopeless task to attempt to give even a brief abstract of this paper; we can only say that it embraces all that could be fairly considered to come within the scope of its title, and we must refer our readers to the original in the pages of the *Transactions* of the Institute.

There was practically no discussion on these two papers, but in answer to a question Mr. Gill stated that an export tax of twenty cents per ton was levied on Bilbao ore, whilst that of the more southern districts was but ten cents per ton.

The paper by Mr. Snelus was next read by the author. The Walrand-Legenisel process had been already described in a former contribution by the same author to the *Transactions* of the Institute, and the object of the present paper was to report progress. It appears that nine firms have taken the process up, and another is thinking about it. The paper should be of considerable value to the proprietors of the process; but that, of course, is by the way.

Dr. Wedding's contribution was, within its limits of space, an exhaustive monograph worthy of a recently created gold-medallist. It begins with a period "long before iron ores were smelted for pig," and carries the subject down to the present day. The problem of the roasting of ores for the purpose of magnetic concentration is of a distinctly controversial nature in its scientific aspect, and doubtless more might have been said than was said during the discussion had not members been under

the influence of unrest, which so often prevails at autumn meetings. Probably the subject will come up again. In the meantime, those interested would do well to study Dr. Wedding's suggestive paper as a means of preparation for future controversy. The following quotation will serve to give a key to the line of reasoning followed :—

"As a rule the roasting is a preliminary to the reduction process. It is only exceptionally or incidentally that it has to effect the purpose of simultaneously eliminating elements, such as sulphur or arsenic, that could detrimentally influence the iron produced. It is only in very recent times that roasting processes have also been employed in order to render iron ores magnetic, so that they can subsequently, by magnetic concentration, be freed from gangue, that is, from constituents not containing iron, and be enriched in iron.

"On considering the composition of the ferruginous constituents of the ores practically employed in the metallurgy of iron, there will be found, as a rule, in the ores supplied by nature, oxides, hydrates, and carbonates of iron: magnetic oxide in magnetite ores; ferric oxide in red hæmatite ores; ferric hydrate in brown hæmatite ores; ferrous carbonate in spathic iron ores, clay iron ores, and carboniferous iron ores. If sulphur compounds occur, which have to be used as iron ores, as, for example, iron bisulphide in iron pyrites, they must always be first converted into ferric oxide (purple ore) before the material can be further utilised in ironworks practice. Again, from the hydrates water must be expelled, and from the carbonates carbon dioxide, before the iron of these ores can be reduced.

"The heats of combination of all iron ores show that a reduction to iron cannot occur as long as sulphur, water, and carbon dioxide are still present. It might consequently be assumed that the only object of roasting was the expulsion of sulphur, water, and carbon dioxide, with a view to the reduction of the iron, were it not that the practical facts were in contradiction to this, in that they show that as a matter of fact even more iron ores that contain neither sulphur, water, nor carbon dioxide, but that consist only of magnetic oxide or ferric oxide, can with advantage be subjected to roasting. The object of this is either to facilitate the subsequent reduction by the formation of the most easily reducible oxygen compounds, or to facilitate the reduction by loosening the texture of the iron ores."

At the conclusion of the reading of his paper, the author pointed out the great use of the thermo-junction pyrometer in work of this nature. He had himself improved the working of this instrument by a shield of asbestos.

Mr. Head's paper was read in abstract, and gave rise to practically no discussion. It was an interesting record of certain professional investigations made by the author into the prospects of mines in the neighbourhood of Santander and Covadonga. Analyses of the ores, cost of working, and other data of a practical nature are given in the paper.

The remaining paper taken at this sitting was that of Messrs. Harbord and Twynam. It was a short but suggestive contribution on what may be called a by-subject, although one not without its practical bearing. The authors agree that nitrogen undoubtedly exists in two conditions in steel. They think it may occur mechanically occluded in the metal, whilst as fixed nitrogen, in combination with some other element, it is undoubtedly present. As the result of investigation, however, they have failed to trace any connection between the amount of nitrogen and the good or bad quality of the steel. Their results appear to confirm the generally accepted opinion that nitrogen, in the proportion in which it is found in commercial steel, has no detrimental effect. Details of tests and analyses are given.

At the second sitting four papers were read in brief abstract before an extremely thin audience, all, excepting a conscientious few, having gone on an excursion of a frankly frivolous nature, there not being even an incipient ore quarry as an excusive for a lunch. Mr. Hibbard's paper was first read. In it the author dwelt, somewhat emphatically, upon the evils of sand sticking to pig; and then proceeded to describe an apparatus he had devised for getting over the difficulty, although whether he had translated his theories into practice did not transpire. So far as could be gathered from the description and illustrations, the ordinary pig bed is superseded by a vast circular table on which are mounted eight radial rows of iron moulds. Sows connect the pigs in the usual way. The moulds are capable of turning, and the pigs are dumped while still red hot, falling into waggons fitted with projections which serve to break them up. (It may be suggested that an objection to this is that the pigs may bleed.) The author states that in one year (1895) purchasers of pig in the United States received 213,750 tons of sand in lieu of iron, and though some allowance is made on this account, the actual loss to purchasers—and corresponding gain to the iron maker—was considerably over a million dollars. These are surprising facts, but the subsequent statement the author makes is even more startling. He says that "the chemist of a great iron-producing firm was commissioned to find a sand which would stick in the largest possible proportion to pig iron"! In the brief discussion an opinion seemed to prevail that the invention was not likely to receive very immediate application in this country.

Mr. Hogg's note on "the missing carbon" was another contribution on a by-subject of the steel-maker. The question has been discussed before, and is likely to come up again, as Prof. Roberts-Austen has promised a communication on the subject, which can hardly fail to be of scientific interest, although, so far, the problem does not appear to have a practical bearing from the steel-maker's point of view. Bearing on this, however, the following passage, with which the author concludes his paper, may be quoted as a warning, from one who can speak with authority, against a reaction that appears to have set in with undesirable force :—

"The various questions of a purely physical nature concerned with the phenomena of hardening are now increasing so rapidly that, for the time being, the chemical side is receiving a somewhat disproportionate share of attention. Probably this may be on account of the generally limited nature of the kind of chemical examination which has to be resorted to. Bearing in mind that the few facts of a purely chemical nature which are known to be intimately related to the physical results are based upon the effects of retarded or accelerated solution, the writer feels confident that, although the labour may at first sight appear to be great in proportion to the results obtained, in time some simple chemical discovery will do much towards rendering the hardening of steel easier to understand."

The valve described in Mr. Colquhoun's paper was illustrated by diagrams, without which it would be impossible to make the details clear. The cooling of valves by water is, of course, by no means a new idea, though possibly the author's arrangement may include points of superiority over anything that has gone before. This was the last paper taken, Messrs. Atkinson's contribution not being read.

The sitting was brought to a conclusion by votes of thanks to the Spanish gentlemen who had done so much hard work to make the meeting a success, and to the President (Sir David Dale), who had occupied the chair throughout.

Mr. E. P. Martin, of Dowlais, will be the next President.

During the meeting excursions were made to ironworks and mines. These we must deal with very briefly.

The Altos Hornos Iron and Steel Works were the first visited. They are situated on the river Nervion, five miles from Bilbao. The following figures relating to their output give an idea of the scope of the works. When in regular work, the product is about 100,000 tons of pig iron yearly. Of this 12,000 tons will be made into puddled iron; 15,000 tons into steel of various sections; 6000 tons into plates; 45,000 tons into rails and bars; 6000 tons into castings; 3000 tons into bridges, roofs and boilers; and 1000 tons into machinery.

The Vizcaya Company's Works, also visited, are likewise on the Nervion. The following is given as the annual production: 200,000 tons of iron ore, 100,000 tons of coke, 100,000 tons of pig iron, 25,000 tons of open hearth and converter (Robert) steel, 6000 tons of puddled iron, and 25,000 tons of rolled iron and steel.

The above are the two principal works, and they are well laid out and equipped. Other iron and steel works are of a smaller character. It may be interesting to state that the production of pig iron during 1894 was in the United Kingdom 7,546,000 tons. In Spain it was 260,000 tons during the same year.

The great excursion of the meeting was, however, that arranged for Thursday, September 3, when the whole day was devoted to a visit to the great Oconera Mines. The weather was extremely favourable, and members had an opportunity of seeing the manner in which iron stone is quarried on these mountains, and at the same time enjoying an exquisite view of the Bay of Biscay—as blue that day as the Mediterranean—and the bold, rocky coast-line backed by the Pyrenees. As we have

stated, there is little to say about the mining operations, so-called. All is in the open. The hill-side is broken out by blasting, the ore is sorted by hand, and is then carried down to the ships in buckets on an aërial railway of wire rope, or by trucks running on inclines. In the level parts near the river locomotives are used, but the great motive power is supplied by the gravity of the material itself.

After leaving the anchorage off the Bilbao River, the *Ormuz* proceeded to Santander, where excursions were made ashore. From thence she went to San Sebastian, where members were landed, and explored the neighbourhood. Finally, the ship was anchored off St. Jean de Luz, from whence Biarritz and Bayonne were visited, and finally the *Ormuz* reached Tilbury once more on Saturday morning, September 12, after having had a most successful fortnight's voyage.

NOTES.

LETTERS have been received from Prof. Sollas, by the Chairman and Secretary of the Coral Reef Boring Committee of the Royal Society, which show that, so far as the main object of the expedition is concerned, the effort has been an almost complete failure. When the party had landed on Funafuti from the *Penguin*, they selected the most promising site, as it appeared, for a bore-hole. The apparatus was landed and set up, and a bore-hole carried down to a depth of about 65 feet, when further progress became impossible, for material like a quicksand was struck which choked the bore-hole. Very little solid coral rock was pierced. To pass over the steps then taken, it may be enough at present to say that another attempt was ultimately made nearer to the edge of the island, where there appeared some hope of finding more solid coral rock. This boring was carried down to 72 feet, and then similar difficulties prevented further progress. The material struck was a kind of quicksand containing "boulders" of coral. As fast as the sand was got out, fresh material poured in, and the water pumped down the tube, with a view of cleaning it, actually flowed out into the surrounding bed, while the coral boulders made it impossible to drive the tubes through the quicksand. So far as the reef was pierced it appeared to be not solid coral, but more like a "vast coarse sponge of coral with wide interstices, either empty or sand-filled." It is very unfortunate that the efforts of the Royal Society, and the liberal aid of the Admiralty and of friends and authorities in Sydney, should be so ill-rewarded; still, though the expedition has failed in its main object, it has met with great success in all the others. Large collections have been made: Messrs. Gardiner and Hedley have thoroughly investigated the fauna and flora, both land and marine, of the atoll. Dr. Collingwood has obtained information of ethnical interest, and Captain Field a series of soundings, both within and without the atoll, which Prof. Sollas states are more complete than have yet been obtained, and must greatly modify our views as to the nature of coral reefs. Of all these matters it would be premature to speak, till Prof. Sollas has returned and been able to give fuller particulars, and Captain Field has reported to the Admiralty.

THE International Congress of Meteorology is meeting this year at Paris, under the presidency of M. Mascart. Several committees or sections have been appointed. One of them has discussed the expediency of an international system of observations to be carried on jointly with the national system. Another has considered the desirability of more frequent international signals, so as to give warnings of storms. The difficulty of delaying the regular traffic was urged as an obstacle, and the section, while desiring a system of circular telegrams at a fixed hour between the national central offices, pronounced in favour of the reception of local reports at each central office in time for international exchanges by 1 o'clock a.m., Greenwich time. Among the proposals made at the Congress is one for the establishment of a station on the coast of Finland, which would issue reports on the break-up of the ice, the movements of icebergs, marine currents, and the prospects of fisheries.

THE Home Secretary has appointed Mr. Thomas Pickering Pick to be the Inspector of Anatomy for the Provinces, in place of Mr. John Birkett, resigned.

THE sixty-eighth annual meeting of the Association of German Men of Science and Medical Men is at present taking place at Frankfort-on-Main. Among the addresses to be delivered during the gathering are:—"Biology and the Science of Health," by Prof. Buchner, of Munich; "The Practical Aims of Military Hygiene," by Dr. Below, of Berlin; and "New Questions in Pathological Anatomy," by Prof. Wiegert, of Frankfort-on-Main. Among the discussions is one on "The Results of Recent Investigations on the Brain," to which Prof. Flechsig, of Leipzig, will contribute a paper on "The Localisation of Mental Processes"; Prof. Edinger, of Frankfort, one on "The Development of the Brain Paths in Animals"; and Prof. von Bergmann, of Berlin, one on "Tumours of the Brain."

WE are sorry to learn, from the *Ceylon Observer*, that Dr. Trimen, the Director of the Ceylon Botanical Gardens, is somewhat seriously ill.

THE death is announced, from Paris, at the age of seventy-seven, of M. Hippolyte Fizeau. M. Fizeau was a member of the Academy of Sciences, and an authority on the velocity of rays of light and of electrical currents.

WE regret to have to record the death, at the age of forty-five, of Dr. G. Brown Goode. He died at Washington, September 6. Dr. Goode was a Member of the National Academy of Sciences, and one of the original Fellows of the American Association for the Advancement of Science at the time of incorporation of the latter in 1874, and had, as our readers will remember, just been elected Vice-President of the Section of Zoology at the Buffalo meeting.

THE death of Dr. Goode, and the absence of Prof. Langley from the United States, prevented the fiftieth annual meeting of the trustees of the Smithsonian Institution (which was to have been held on September 7) from taking place. This was the first time in the existence of the Institution that the annual meeting had failed to be held.

NEWS has been received of the massacre, on August 10, by natives of Guadalcanar of the Solomon Islands, of a portion of a party, detached from the Austrian war vessel *Albatross*, for purposes of scientific research. It is reported that Baron Foullon, a geologist, a midshipman and two sailors were killed, and six others wounded, four seriously. Efforts made by the British Resident to recover the dead bodies were unsuccessful.

A REUTER telegram from St. Petersburg, dated September 17, states that a telegram from Vladivostok announces that the expedition for the exploration of Kamtchatka, under MM. Bogdanovitch and Lemiakin, has made a thorough survey of the district between Chumikan and Ayan, discovering some rich gold-fields of considerable extent. Gold of remarkably good quality has been discovered in fourteen places in volcanic strata on the banks of the river Aikashra.

THE correspondent of the *Standard* at Rejkjavik, writing on September 11, gives an account of the recent earthquakes in Iceland. The first shock occurred on the evening of August 26, and it was followed by another, somewhat less severe, the next morning. These shocks were felt over the whole south-west of the island, but were most violent in Rangarvalla Syssel, which

lies directly to the south of Hecla. In this district, fifty-five badly-built farmhouses were destroyed, but no lives were lost. Occasional tremors were felt during the following days, but none of any severity until the night of September 5, when there was another violent shock. In this the epicentre was displaced to the west, Rangarvalla Syssel was but little affected, and most damage was done in Arnes Syssel. Here more than one hundred farmhouses were destroyed or seriously damaged, and two persons were killed. Four hours later another strong shock was felt, and since then there have been frequent tremors, but none of sufficient strength to do further damage. No eruption has taken place, and no signs of an incipient eruption are visible. The Great Geyser, being at some distance from the epicentre, showed little change except a temporary increase of energy. But in several other places hot springs had dried up, while at one or two points fresh boiling springs have made their appearance.

ACCORDING to mail advices from Rejkjavik, received on September 21 in Copenhagen, two fresh shocks of earthquake occurred in the south-west of Iceland on the night of the 6th, and at one place an old couple were killed by the roof of their house falling in. It is stated that 155 farmsteads were destroyed during the recent earthquakes. To the fund that is being raised in Denmark for the victims, the Tsar has subscribed 4000 kronen, and the Dowager Empress of Russia 3000, while donations of 2000 and 1000 kronen have been given by the King and Queen of Denmark.

THE *Athenæum* states that a new Alpine meteorological station, corresponding to that on the summit of the Santis, is to be erected on the Rochers de Naye. President Ruffy and Prof. Hagenbach-Bischoff, of Bâle, members of the Swiss Federal Meteorological Commission, are at present searching for a suitable site for the erection of the building.

WITH reference to the note appearing in these columns of September 3, respecting the finding of gold in Newfoundland, a telegram from St. John's announces that an analysis from a London firm shows that the bed-rock under the quartz yields 8 dwts. 12 grs. of gold per ton, while the quartz itself yields 3 ozs. per ton. The bed-rock is said to be of unlimited extent, and only one vein of quartz has yet been worked.

MR. GEORGE J. GOULD, of New York, has recently returned from a tour in Arctic waters in his private yacht. He has decided, it is said, on an elaborate and systematic scheme of exploration, which includes the building of a permanent depôt at some point always accessible during the season of navigation, and the sending of supplies to it every year. A cordon of depôts will be established at points further north from year to year, and will be permanently equipped and maintained till the Pole has been reached.

OUR American correspondent, writing on September 11, says that elaborate experiments in aërial locomotion are in progress at Dune Park, Northern Indiana, near Lake Michigan, under the direction of Mr. Octave Chanute. The experiments began two months ago. Since then the machines have been reconstructed. Mr. A. M. Hering is assisting Mr. Chanute, and has invented a regulator which is attached to the apparatus. Beginning about September 1, about seventy-five flights have been made without a bruise or a break. A distance of 300 feet has been covered, at the height of about 30 feet from the ground, with less jar and shock than a ride in a rubber-tyred carriage. Two men carry the apparatus up the sand-hill. About 35 feet up, the machine is lifted, and Mr. Hering fits himself under it, and allows the wind to raise it. His arms fall over the bars provided. He makes two or three quick steps towards the lake, and the machine soars from the ground and darts through the air with a velocity described as rivalling that of an express train. The motion is horizontal, without any swaying motion. To stop the machine, the operator moves his body enough to tilt the apparatus slightly upwards in front, when it coasts gradually and slowly to the ground. The experiments of September 10 were considered unusually favourable, because made under somewhat adverse conditions. In a strong wind, the aëroplane soared suddenly and unexpectedly, carrying with it four operators who were holding the ropes, and lifting them 100 feet into the air. The combined weight of the four brought it down again soon without accident; whilst the performance of the machine in this emergency was peculiarly gratifying to the inventor. The apparatus is modelled after the general form of an albatross, but has seven wings. A very elaborate machine, constructed on a different principle by Mr. Paul, was to be tested on September 11, if favourable conditions prevailed, and some extraordinary results were anticipated. This machine has four corners which rest upon a chute, the upper end of which is 90 feet from the ground, and the lower end 77 feet above the lake level.

WE learn from *Science* that the ironwork of the dome of the Yerkes Observatory is in position, and the lenses, now in the hands of Mr. Alvan Clark, will, it is hoped, be ready to be moved before the coming winter. The dome is 110 feet high, 90 feet in diameter, and weighs 200 tons.

SIR WILLIAM HERSCHEL'S system of identifying persons by thumb-marks has been introduced experimentally into Bengal. The chief object of the measure appears to be to identify Government pensioners, and to make it impossible for persons to impersonate them.

ACCORDING to the *Lancet*, a new medical journal is likely to be started in Scotland in the coming year. A committee on the subject has been formed by members of the profession, and has been for some short time actively engaged in making inquiries as to the probable success of the proposed journal, and discussing arrangements. What the proposed arrangements and scope of the enterprise are, have not yet transpired.

A NEW journal, entitled *Revista Trimestral Micrografica*, is to be published, under the editorship of Prof. S. Ramon Y. Cajal, of Madrid.

DR. R. H. TRAQUAIR will deliver the Swiney course of lectures on "The Geological History of Vertebrate Animals," in the Lecture Theatre of the South Kensington Museum, on Mondays, Wednesdays, and Fridays, beginning Monday, October 5, and ending Friday, October 30. There will be twelve lectures in all, and admission will be free.

THE lecture arrangements at the Royal Victoria Hall, Waterloo Bridge Road, for the month of October are as follows:—October 13, "Arabia," by Mr. Theodore Bent; October 20, "Chronicles of a Clay Cliff," by Mr. W. H. Shrubsole; October 27, "The Great Barrier Reef of Australia," by Mr. R. Kerr.

OFFICES for the identification of criminals under the Bertillon system have been established in Ceylon, at Colombo, Kandy, Galle, Kurunegala, and Ratnapura. The authorities, however, seem to have some difficulty in finding constables sufficiently accurate and delicate in their touch, and of enough education to undertake the work. Of those put into training only a limited number eventually qualify. In the recently published administrative report, mention is made of the following curious effect of the system. A number of habitual criminals of Colombo, who object to being identified, have left the town.

AN international exhibition will, as was briefly announced in NATURE of August 13, be held in Brisbane in 1897. The Government of Queensland has granted its official patronage to

the undertaking, and Sir Arthur Hunter Palmer has accepted the office of President. The exhibition is to be opened on May 5, and will remain open for about three months. Its objects, as described in the prospectus issued by the acting Commissioner in London, are: "To promote and foster industry, science, and art, by inciting the inventive genius of our people to a further improvement in arts and manufactures, as well as to stimulate commercial enterprise by inviting all nations to exhibit their products, both in the raw and finished state. Samples of the products for which this and the other Australasian colonies have become famous will be exhibited, with a view to increase the development of their natural resources."

The French Congress of Medicine is to be held during the Easter holidays of 1898 at Montpellier, under the presidency of Prof. Bernheim, of Nancy. The questions proposed for discussion are: (1) The clinical forms of pulmonary tuberculosis, (2) microbic associations and mixed infections, (3) therapeutic use of organs with internal secretion.

The novelty of the idea of trying to reach the North Pole in a balloon seems to have worn off to some extent, so that there is a good chance now for a new suggestion. For this one has not had very long to wait, since the latest seems to be to make the attempt in a submarine boat. There is, however, as far as we know, no one at present who is going to make this perilous journey; but it is only the idea that has been suggested. The author of this is M. G.-L. Pence, and his views on the subject will be found in the *Revue Scientifique* (No. 12). Evidently this method of reaching the pole was brought home to him after having read that Nansen had found no shallow soundings above a certain high latitude. Relying on this fact and another, viz. that the polar seas are not entirely covered with ice throughout their length and breadth, but are here and there open to some extent, he suggests that the submarine boat could then often emerge to the surface to make observations and recoup fresh air. There seems, however, to be no suggested difficulty about finding the necessary pools; it is true that he mentions electric search-lights *pour reconnaître les écueils ou îlots sous-marins*, but it would be distinctly awkward for those on board if no openings were found. The navigation also would not be an easy matter, since we know very little about the variation of the compass in these regions. The writer, M. Pence, seems, however, to be aware of the fact that greater progress must be made in the building and management of submarine boats before any such attempt could be seriously carried out; but it appears to us that the proper place for such a boat would be in deep water, especially free from shallows and ice, and not rendered incapable of rising to the surface by the intervention of ice perhaps yards thick.

The additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*) from India, presented by Mr. W. J. Drake; two Brown Capuchins (*Cebus fatuellus*,) from Guiana, presented by Mr. Walter Hammond; a White-crowned Mangabey (*Cercocebus æthiops*), a Diana Monkey (*Cercopithecus diana*) from West Africa, presented by Captain B. Parmeter; two Chacma Baboons (*Cynocephalus porcarius*) from South Africa, presented, respectively, by Mr. Herbert Blair and Mrs. Matcham; a Black-headed Lemur (*Lemur brunneus*) from Madagascar, presented by Mr. T. Cubitt; a Lioness (*Felis leo*) from Arabia, presented by Mr. C. A. Osborne; three Chipping Squirrels (*Tamias asiaticus*) from Washington State, U.S.A., presented by Mr. Alfred E. Speer; four Common Quails (*Coturnix communis*) from North Africa, presented by Mr. J. Rooney; a Tawny Owl (*Syrnium aluco*), British, presented by Mr. C. A. Lowes; a Little Grebe (*Tachybaptes fluviatilis*), British, presented by Mr. Howard Bunn; two Salt-water Terrapins (*Clemmys terrapin*) from North America, presented by Master and Miss Wilcox; two Dwarf Chameleons (*Chamæleon pumilus*) from South Africa, presented by Mrs. Robinson; a Common Hare (*Lepus europæus-albino*), European; a Two-wattled Cassowary (*Casuarius bicarunculatus*) from the Aroo Islands, a Naked-throated Bell Bird (*Chasmorhynchus nudicollis*) from Brazil, a Levaillant's Cynictis (*Cynictis levaillanti*), a White-crested Touracou (*Corythaix albocristata*) from South Africa, three Maguari Storks (*Ciconia maguari*) from Chili, deposited; a Spotted Cavy (*Cœlogenys paca*) from South America, a Viverrine Cat (*Felis viverrina*) from India, an Ariel Toucan (*Ramphastos ariel*) from Brazil, purchased; two Pumas (*Felis concolor*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

The Recent Solar Eclipse.—Prof. H. Geelmuyden communicates to *Astr. Nachr.*, No. 3378, some of the observations made at this eclipse. M. Schroeter, of the Observatory of Christiania, noted the time of the arrival of the shadow from his station near Vadsö as 16h. 57m. 0·5s. Central European time, with an error of $\pm$0·5s., the end of totality occurring at 16h. 58m. 41s. with a possible error of several seconds. He remarks also of the "peu d'obscurité" during totality. In spite of the clouds, he says he could read and write without difficulty at a distance of 50 cm., and could follow the seconds hand on the face of his chronometer, placed at a distance of 1·4 metres. This, however, was not the experience of the observers across the Varanger Fjord on the island at Kiö. The eclipse, as observed there, was described by general consent as an exceedingly dark one, and the timekeepers, with stop watches and chronometers, all required some kind of artificial illumination. M. Mohn, who was in Finmarken to inspect the meteorological stations, was situated at Bugones, on the southern side of the Varanger Fjord. He remarks that during totality he could read the smallest letters of a journal. One of the fortunate observers, M. Lous, was stationed near Bodö on the summit of a mountain, Hegmotind (lat. 67° 25′, long. 14° 58′ E. of Greenwich, height about 500 metres). He used a small telescope by Plössl, aperture 26 mm., magnifying 14 times. After totality was over he made a sketch of the corona, from which the following description has been gathered. The angles referred to below are measured from the top in the ordinary way.

From 350° to 50° and around 180° the size of the corona was 16′. From 50° to 130° or 140° there was an extension of 30′, divided by a radial suppression between 80° and 90° inclined towards the inner corona. From 280° to 350° were two tufts meeting at their bases nearly at 310°, and both pointed at their exterior edges; the largest extension of one was 36′ between 290° and 300°, the other rose to 50′ between 330° and 340°. The latter was nearly vertical. These red prominences were seen at 75°, 100°, and at 280°, the last being visible to the naked eye. The above numbers are only approximate.

One of the party of astronomers who went out to Japan to observe the eclipse, has communicated an article to the *Times*, from which we make the following summary. Akkeshi Bay was the spot finally settled upon for making the observations, this place being situated on the island of Yezo, and lying somewhat to the north of Kushiro. H.M.S. *Humber* conveyed the party thither, and on their arrival they found that there were already five ships anchored in the bay, including the flagship *Centurion*. On landing it was discovered that Prof. Schaeberle, accompanied by Mr. Charles Burckhalter and two amateur astronomers, had already taken up their positions at a tea-house in the village, the instruments having been set up in the garden. Prof. Schaeberle's 40-feet telescope "was propped up against a rock, which seemed to have been providentially placed there for him." Our *confrères* determined to follow their example, and they consequently established themselves at another tea-house, and "we never saw reason to regret this choice." Prof. Shin Herayama was similarly situated about a mile away in a third tea-house. Passing over the description of the erection of the instruments, and other facts mentioned in the article, we come to the following account of the eclipse. "All, in fact, went well, and even merrily, until the fatal day, which was gloomy throughout. The sun did show himself at noon, and at intervals afterwards, but twenty minutes before totality the clouds shot down finally. Not a vestige of the corona was seen. The sky grew suddenly dark, of course,

and we had the seconds of totality properly counted, in the faint hope of a break in the clouds, but nothing came of it, and the brightening sky soon told us that all was over."

COMET GIACOBINI.—The following ephemeris for the ensuing week is a continuation of that previously given, the elements remaining the same. September 5 is taken as the unit of brightness:—

1896.	α h. m.	δ ° ′	log Δ	B.
Sept. 23	17 59·3	−10 58	9·7255	1·6
25	18 6·4	11 22		
27	18 13·9	11 47	9·7088	1·8
29	18 21·9	12 11		
Oct. 1	18 30·4	12 36	9·6919	1·9

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

A POST-GRADUATE course of Bacteriology has been established at the University of Sydney, New South Wales.

IT is announced that Prof. F. F. Jerisman has resigned the chair of Hygiene in the University of Moscow.

MR. W. R. BOWER has been appointed Lecturer in Physics and Applied Mechanics at the Huddersfield Technical School.

PRESIDENT G. T. WINSTON, of the University of North Carolina, has been elected President of the University of Texas.

Science states that by the will of the late Martin Brimmer, of Boston, Harvard University, on the death of Mrs. Brimmer, is to receive the sum of £10,000.

THE six buildings of the New York State Veterinary College of Cornell University have, according to *Science*, been completed, and the fitting-up of the laboratories and museums is taking place.

IN the Owens College Zoological Laboratory, Mr. Gamble will conduct an evening class on British Marine Zoology. Demonstrations of the structure, life-histories, and methods of capture of examples of the chief groups of animals found in the British seas, will be given at each meeting.

SIR PHILIP MAGNUS, Director of the City and Guilds of London Institute, Mr. Gilbert Redgrave, of the Science and Art Department, Mr. Smith, of Keighley, and Mr. W. Woodall, M.P., who were colleagues on the Royal Commission on Technical Education which reported in 1883, are at present engaged in an unofficial tour of inspection of exhibitions, schools, and factories in Germany.

THE following appointments abroad have taken place:—Dr. C. Winkler to the chair of Nervous and Mental Diseases, and Dr. Lobry van Froostenburg de Bruijn to that of General and Pharmaceutical Chemistry, each at Amsterdam; Dr. E. Lesser as Extraordinary Professor of Dermatology at Berlin, Dr. Chermak to the chair of Comparative Anatomy and Embryology at Jurieff (Dorpat), Dr. L. Niemilovicz to be Ordinary Professor of chemistry, Dr. Wenzel von Sobieranski to be ordinary professor of Pharmacology and Pharmacognosis, Dr. Andreas Obezut to the chair of Anatomy, and Dr. Prus to the chair of General and Experimental Pathology, each at Lemberg.

THE prospectus of day and evening classes in connection with the South-west London Polytechnic Institute during the coming session has just been issued, and contains all necessary information respecting the fourteen sections into which the general scheme of work may be divided. The Institute was opened rather less than a year ago, but already 1400 students have availed themselves of its great educational advantages. Judging from the well-executed illustrations in the prospectus, the various laboratories and workshops are well arranged and fitted with latest appliances. Hitherto the work of the Institution has mainly taken place in the evening, but on September 29 a new departure is to be made, and it will from that time be open to day students in mathematics, mechanics, mechanism, architecture and building construction, drawing-office work, electrical technology, physics, chemistry, and applied art. The objects of the day classes are: (1) To give that preparatory training which will fit students over fifteen years of age for practical work in the factory or engineer's shop, or prepare them for colonial life. (2) The education of pupils from middle-class and other schools, who are preparing for a higher technical and scientific course of instruction, such as is provided at the Central Technical College, Exhibition Road.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 14.—M. A. Chatin in the chair.—On an exceptional rainbow, by M. Berthelot.—On the stability of the rods employed as provisional bench-marks in levelling of precision, by M. C. Lallemand. Small errors are introduced into accurate levelling by the slight settling down of the temporary wooden bench-marks. It is shown that these errors can be readily distinguished from errors due exclusively to accidental causes. The error due to settling is practically a linear function of the time elapsing between successive measurements on the same rod.—On the tornado observed at Paris on September 10, 1896, by M. A. Angot. The cloud, seen from a distance of about 1000 metres, was in obvious rotation, the direction being from right to left, in the opposite direction to the hands of a watch; the rotation was also accompanied with an ascending movement, easily traced by watching an isolated piece of cloud. Not the least remarkable point was the absolute sharpness and small size of the destructive zone, at a comparatively small distance from which the wind velocities were quite normal. The slight fall of the barometer, preceding the disturbance, was no greater than would occur during an ordinary rain shower.—On the same, by M. J. Jaubert. The direction of rotation could be determined from the direction of the trees torn down by the passage of the tornado, and was from right to left. The direction of translation was in a straight line from south-west to north-east; with a velocity of at least 40 to 50 metres per second.—On the simultaneous presence of laccase and tyrosinase in the sugar of some mushrooms, by M. G. Bertrand. Both these ferments were found in the extract from *Russula cyanoxantha*, and *fætens*.—Stability of blood rendered incoagulable by extract of the leech, by MM. Bosc and Delezenne. Two specimens of blood from the same animal, taken before and after intravenous injection of extract of leech, and placed side by side at a temperature of 20° to 22° C., show a marked difference in their rates of putrefaction, the second specimen decomposing much more slowly than the first. This result cannot be due to any special antiseptic action of the extract, since numerous species of bacteria can be readily cultivated in it. It is shown that active amœboid movements of the white corpuscles continue in the treated blood at the ordinary temperature, and hence it appears probable that putrefaction occurs only in dead blood, in which there are no living leucocytes. It is also possible that the extract from the leech may provoke secretions by the leucocytes which augment the bactericidal action of the blood.—New adaptation of the muscles of the leg after recovery from a club-foot, by M. Joachimstal.—On the sulphide of magnesium, and on some salts of alumina, by M. Bignan.

CONTENTS.

THURSDAY, OCTOBER 1, 1896.

CHEMISTRY IN DAILY LIFE.

Chemistry in Daily Life: Popular Lectures. By Dr. Lassar-Cohn. Translated by M. M. Pattison Muir. Pp. x + 324. (London: Grevel and Co., 1896.)

A BOOK which professes to instruct the public, uninitiated into technical language or methods, concerning the results of the application of scientific principles to the purposes of daily life, must possess a combination of qualities not easily associated together. It ought to be true—that is, the positive statements it contains ought to be facts, and yet, though its pages should present the truth and nothing but the truth, it is impossible that it should give the whole truth in regard to many subjects it must pretend to discuss. Here is the grand opportunity for the exercise of judgment on the part of the writer, without which and a large proportion of sympathy with his readers the book will be both unintelligible and uninteresting. There must be—and there are—many subjects which, from their nature, are incommunicable to the mind not already prepared with a knowledge of fundamental ideas and some familiarity with the technical language or symbols by which these ideas are expressed. Such subjects as many divisions of pure mathematics and, we will venture to add, of modern chemistry belong to this category.

However, acting upon the view that the best test of the suitability of such a book for the general reader is not merely the opinion of the chemical expert on the subject-matter and the degree of accuracy of the notions introduced, the writer of this notice has placed this little volume in the hands of an educated but not technically instructed friend, with a request to read it carefully, appealing for help or explanation if necessary. This is the kind of thing that follows:—

"Please tell me the meaning of this: 'The green parts of the leaves are called chlorophyll-grains,' also 'silica is the chemical name for pure sand'; and, pray, what is humus?" (pp. 38–40).

A little later the reader says:

"Listen: 'A cannon exhibited by Krupp at the Chicago Exhibition, when charged with 115 kilos of this powder, propelled a shot weighing 215 kilos to a distance of 20,226 metres; the flight of the shot occupied 70 seconds, and the highest point attained was 6540 metres above the earth, while the height of Chimborazo is only 6421 metres.' What does all that mean, and what has the highest point got to do with it?"

These are sufficient examples of the, perhaps, not very serious difficulties encountered by the general reader, who at the end remarked, "Oh, yes; I found it interesting."

Now let the chemist take a look at the volume. As already hinted, the impossibility of stating some things without resort to technical language leads to a great deal of extremely loose and objectionable phraseology. Take the following passage (p. 46) for example:—

"Most of the phosphoric acid in the materials we have mentioned is combined with lime in the proportion of three molecules of lime to one molecule of the acid. Sulphuric acid is a stronger acid than phosphoric; but one molecule of sulphuric acid combines with only one molecule of lime. If then two molecules of sulphuric acid are caused to react with burnt bones or mineral phosphorite, a new compound is obtained, in which one molecule of phosphoric acid is combined with one molecule of lime, and, at the same time, two molecules of sulphate of lime or *gypsum*, as it is commonly called, are formed. The following scheme makes the process more evident.

	Lime	+	Sulphuric Acid
Phosphoric Acid	Lime		Sulphuric Acid
	Lime		

Here we have a series of statements all more or less open to criticism, the culminating misrepresentation being embodied in the scheme, which asserts that sulphuric acid withdraws lime from the phosphate without leaving anything in the place of it. This, however, is just the kind of thing which it is well-nigh impossible to express correctly in popular language. The worst of it is that the same erroneous idea crops up in so many other places. The worst case we have encountered occurs on p. 51, where ammonia is said to be "an alkali or a base, for these names have to-day the same meaning." And a few lines further on it is announced that "bases and acids may be gases, liquids, or solids. Ammonia, for instance, is a basic gas, carbonic acid is an acid gas, sulphuric acid is a liquid, and silicic acid is a solid." After such a descent towards the popular level, it is difficult to believe that anything can be gained by the introduction of chemical formulæ, especially such as occupy the last ten pages, where an attempt is made to explain the constitution of alkaloids and other complex carbon compounds.

All this kind of thing was managed much more successfully in "The New Chemistry" of the late Prof. Josiah P. Cooke, which, though published twenty years ago, is still trustworthy and, in point of literary quality, incomparably superior to such a jumble of information not always to be depended upon for accuracy, and sometimes descending to the almost ludicrous. One cannot but wonder whether the author was serious or cynical when he wrote that phosphoric pig-iron "is only fitted for making the coarsest sorts of cast-iron ware, such as *railings for graves* and the like, *in which no great durability is looked for*." The italics are ours.

The author does not often exhibit emotion, but bimetallism is too much for him, and he lets his pen run. The whole story is too long to quote, but one passage affords such a remarkable example of style, unspoiled by a conscientious translator, that it is worth reproducing.

"There is one thing which the bimetallists would certainly achieve, as long as they do not get rid of the fluctuations in the price of silver, were they to induce the civilised States to inaugurate an international bimetallism in that Utopia which they depict to any one who will hearken to them as the approaching economical rejuvenescence of the nations—for none of them has brought forward a decisive argument in favour of their assertions because no such argument exists, for if there were such an argument it would certainly be easy to induce the most influential nations to adopt bimetallism again—and this one thing which they would undoubtedly do would be to enable the proprietors of American and Australian silver mines, one of whom is already the richest man in the world, to make yet much greater

profits from their mines, in which profits Europeans have as yet no great interests," &c.

After this it is not surprising, as the translator informs us in the preface, that the publication of the book "caused quite a stir in German circles."

OUR BOOK SHELF.

Crystallography for Beginners, with an Appendix on the use of the Blowpipe and the Determination of Common Minerals (after the method of Dr. Albin Weisbach). By C. J. Woodward, B.Sc. Pp. 164. (London: Simpkin, Marshall, Hamilton, Kent and Co., Ltd., 1896.)

IN a preliminary chapter of this book the student is taught how to prepare for himself, with due regard to economy of purse, a set of models to be used in connection with the various lessons. In the course of the following 72 pages the constancy of the angles of crystals, symmetry, notation, drawing of crystal forms and spherical projection, are in turn explained. The physical properties of crystals are then briefly touched upon, and in a last lesson mero-symmetry is discussed. The appendix (55 pages) deals with a subject entirely different from Crystallography, namely Determinative Mineralogy, and is made up almost wholly of tables drawn up after the manner of those of Dr. Weisbach. The book contains numerous woodcuts in the text, and is furnished with four plates, two of them consisting of diagrams to be pasted on cardboard and used in the construction of the aforementioned models. To each lesson is appended a set of useful questions relating to the subject which has been discussed. Some of the statements are wanting in accuracy: for instance, on page 55 the student is told that "the symbols of all planes in a zone have two of their indices always in a constant ratio," which is untrue; and at times the language is wanting in neatness and precision: still, if the student is in the hands of a careful teacher, he will be able to get much help from the book, and is not likely to be led astray.

By the Deep Sea; a Popular Introduction to the Wild Life of the British Shores. By Edward Step. Pp. 322. (London: Jarrold, 1896.)

THE author of this little volume is already favourably known by his popular books on wild flowers, &c., and the present work will add to his reputation as a writer for the non-scientific reader. The author's endeavour has been to introduce to the seaside visitor a large number of the interesting creatures to be found on the rocks, the sands and the shingle, and he claims to have written the whole of the work in close contact with the objects he describes—not only of cabinet specimens, but of the living creatures under natural conditions. In his own words: "There is not a line in the whole volume that has not been written within a few yards of, and in full view of the rocks." The twenty chapters into which the book is divided are devoted to the sea and its shores, low forms of life, sponges, zoophytes, jelly-fishes, sea-anemones, sea-stars and sea-urchins, sea-worms, crabs and lobsters, shrimps and prawns, some minor crustaceans, barnacles and acorn-shells, "shell-fish," sea-snails and sea-slugs, cuttles, sea-squirts, shore fishes, birds of the seashore, sea-weeds, flowers of the shore and cliffs. The style of writing is easy and attractive, and the text is further elucidated by the insertion of a number of well-chosen, if somewhat rough, illustrations from the works of P. H. Gosse, and others which appear to have been specially drawn for the work. Many a seaside holiday will be more fully and permanently enjoyed by the study of this tastefully got-up little book, the usefulness of which is increased by a general and a classified index.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Utility of Specific Characters.

I HOPED that I might have held my peace on this subject. Prof. Lankester, however, complains, and not for the first time, that I have misrepresented, or at any rate misunderstood him.

I do not doubt his acquaintance with Prof. Weldon's work, though he has allowed a long time to elapse before criticising it. I am glad that he regards it as "interesting and valuable." But this is what he said about it in NATURE for July 16 last:—

"Such methods of attempting to penetrate the obscurity which veils the interactions of the immensely complex bundle of phenomena which we call a crab and its environment, appear to me not merely inadequate, but in so far as they involve perversion of the meaning of accepted terms and a deliberate rejection of the method of inquiry by hypothesis and verification, injurious to the progress of knowledge."

It is quite true that Prof. Lankester has not said in so many words that "Prof. Weldon's investigation of the crab's carapace 'does not satisfy the canons of scientific inquiry.'" But it appears to me that this is a very mild way of putting what he did say.

I expressed the opinion that Prof. Weldon's investigation did rest on an hypothesis, and that this was subjected to verification. Whether the hypothesis was reasonable and the verification adequate is a matter on which Prof. Karl Pearson and others are entitled to form their own judgment.

Kew, September 28. W. T. THISELTON-DYER.

I FEEL grateful to Prof. Karl Pearson for his lucid and rational contribution to this discussion, in which it has sometimes seemed to me that the main question was in danger of being obscured by more or less irrelevant arguments.

I pointed out in a letter to NATURE, soon after the publication of Prof. Weldon's report last year, that he had not, and had not claimed to have, proved that there was a differential or selective death-rate in shore crabs, with respect to variations of their frontal breadth. He showed that the curve of variation in larger (and therefore presumably older) crabs was different from that in smaller crabs. The departures from the mean were less. He concluded, that if this difference were not due to growth-changes it must be due to the death of crabs with extreme variations. But on the other hand it had to be proved that the difference was not due to growth-changes. Changes in the proportions of parts are so common during growth in so many animals, that it seemed to me much more likely that the difference discovered by Prof. Weldon was due to such changes than to a differential death-rate. I understand that he has since been investigating what he calls the law of growth in these crabs, but so far as I know he has not published any further results.

I am glad to find that Prof. Karl Pearson's opinion concerning the conclusions to be drawn from the evidence published by Prof. Weldon, entirely agrees with mine. It would be very interesting to learn now whether Prof. Weldon is able to settle the question of the changes occurring in the growth of shore crabs, and either to confirm or withdraw his suggested conclusion that the difference he described was due to selective death-rate. It would take a good deal of evidence to convince me that shore crabs in which the frontal breadth differed slightly from the mean, died in greater numbers than those in which it was nearer the mean. But if the evidence is forthcoming, I am ready to accept it. It seems to me that Mr. Thiselton-Dyer is inclined to accept the conclusion before the evidence is forthcoming. He seems to have overlooked the other possible explanation of the result, namely changes in the same crabs during growth.

I also maintained in my letter last year, as Profs. Lankester and Karl Pearson maintain now, that if a differential death-rate were demonstrated, it would still be necessary to discover how that death-rate was caused, what was the relation between the character in question and the conditions of life which caused individuals with certain variations of the character to die off.

I do not profess to be a specialist in logic, but it seems to me that the fallacy into which Prof. Weldon has fallen is that of confounding the categories. He maintains that if a certain

variation is correlated with a certain death-rate, it must be the cause of it, and that it is not possible to distinguish between variations which are directly useful, and those which are only physiologically correlated with the useful. But it seems to me that this is like talking of hitting a nominative case with a stick. The variation is a magnitude in an organism, survival or death is a relation between the organism and its environment. It is the relation of the variation to life which alone can be said to be the cause of death or survival. The relation to the conditions of life is advantage, disadvantage, or neutrality in the struggle for existence. If I have stated the logic of the matter correctly, I venture to think that the apprehension of this principle is a necessary preliminary to any attempt to demonstrate empirically the occurrence of natural selection.

Prof. Weldon's chief contention was that by the statistical method, when the law of growth of the characters examined was known, a measure of the rate and direction of the evolution of an organism could be obtained. Such a measure would be afforded by the selective death-rate. But he has not yet demonstrated a selective death-rate in a single instance. And further, a measure of the rate and direction of evolution has nothing to do with the cause of the selective death-rate. If characters of no apparent utility are proved to be subject to selection, there still remains the question how the selection is brought about. Measures of the rate and direction of the wind do not tell us the cause of the wind. They may help us to discover the cause, and I have no doubt that Prof. Weldon's investigations are a valuable contribution to the investigation of evolution. But it is only when it has been shown that the degree of utility of a variation, or its correlation with useful variations determines its survival, that the occurrence of natural selection has been demonstrated. J. T. Cunningham.

September 19.

Fossil Tridacnids in the Solomon Islands.

Some months ago, on the voyage between New Guinea and Sydney, the small trading steamer on which I travelled called at a number of islands in the British Solomons, the first station at which we called being Rubiana, in the little-known island-complex of New Georgia. Here I became acquainted with the heavy arm-rings worn by the natives, and obviously made from the shell of *Tridacna* or *Hippopus*. What was very surprising, however, was the information which I obtained from all quarters and from different localities, from blacks as well as from whites, that these arm-rings are not made from recent shells found on the reef, but from shells obtained far away in the interior, or, as they say, in the bush. At first sight, the arm-rings, above referred to, strongly remind one of those made from the recent *Tridacna* by the natives of the Sir Charles Hardy Island, which lies to the north of the Solomon Group; but while the former are solid rings more than half an inch in thickness, the latter are deeply grooved on the outer border.

This difference is shown in Figs. 1 and 2, which represent cross-sections through the arm-rings of the Solomon and Sir

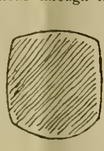


Fig. 1.

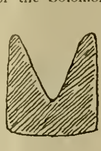


Fig. 2.

Charles Hardy islanders, respectively. But there are other differences, not so much of artistic as of economic importance. The grooved rings are much more readily obtained from the natives who make and wear them, than are the solid rings. The latter have a great value among the natives themselves, and when they are shot with a vein of reddish or reddish-yellow colour (derived no doubt from the hinge-line, which also gives their beauty to the nose-pieces of the New Guinea natives), they can only be mentioned with bated breath.

The reason why the Solomon Islanders prefer the ancient to the recent shells, lies possibly in the fact that, as a general rule, among the natives of the larger islands of the Pacific, the artists and artificers (apart from the making of canoes) are to be found among the bush-natives, rather than among those who live in proximity to the sea. The latter are traders, *par excellence*—men of the world who do their business in great waters. The former live in primitive innocence, are possessed of uncouth manners, and produce poets, magicians, medical men, and professional dancers, together with workers in wood and stone. To the last-mentioned members of the community, therefore, the Tridacnid shells, when they occur in the bush through elevation of a former coral reef, are ready conveniently to hand.

I have thought it worth while to draw the attention of naturalists to the above indication of the existence of upraised coral reefs in the Solomon Islands, which would be well worth an attentive examination, and, while in Sydney, Mr. R. Etheridge, jun., informed me that he knew of other instances in the Pacific of coral reefs having been raised to an elevation of over a thousand feet. Arthur Willey.

Nouméa, New Caledonia, July 16.

Visual Aid in the Oral Teaching of Deaf Mutes.

Probably every one is acquainted with Kœnig's manometric capsules and revolving mirrors, and it occurred to me that I might help a deaf mute to learn inflection in speaking by his imitating the curves produced by my voice in the mirrors. For this purpose I arranged two capsules with oblique membranes and small diameter side by side, one being higher than the other, so that two bands of flame half inch wide, and half inch apart, appeared in the revolving mirrors. The capsules were tuned alike, and furnished with tubes and conical mouthpieces; through one of these I made the sound of a note, vowel, or syllable in various pitches, and my friend endeavoured to imitate through the other tube the curve in the flame band produced by my voice. As an experiment the results were quite satisfactory, for before an hour was over he could imitate a range of nearly an octave, and would tell me correctly, through watching the curves of flame, when the note he uttered was like mine. I am not interested in the oral teaching of the deaf, but having frequently to use Kœnig's invention, I think the principle might be made useful to oral teachers. My friend, upon whom I experimented, is said to have been well taught, his age about twenty years, but his voice (?) is a hoarse monotone. T. Hawksley.

11 Primrose Hill Road, N.W.

INTERNATIONAL METEOROLOGICAL CONFERENCE AT PARIS.

This Conference was held at the rooms of the Société d'Encouragement, in the Rue de Rennes, from September 17 to 23. About forty members were present. M. Mascart was elected President, MM. de Bezold and Tacchini Vice-Presidents, and MM. Angot, Erk, and Scott Secretaries. The complete report of proceedings has not yet been printed. It was decided that Committees should be appointed to continue the investigation of several subjects, viz.:

I. Terrestrial Magnetism and Atmospheric Electricity; Prof. Rücker (President).

II. Clouds; Prof. Hildebrandsson (President).

III. Radiation and Insolation; M. Violle (President).

IV. Aerostatics and Balloon Work; Prof. Hergesell (President).

On the motion of Mr. Symons, the International Meteorological Committee was reappointed with a few changes, rendered necessary by the respective resignations of Prof. Wild, Prof. Harrington, and Mr. Ellery. The President is Prof. Mascart, and the Secretary Mr. R. H. Scott.

ARMAND HIPPOLYTE LOUIS FIZEAU.

By the death of M. Fizeau physical science has lost one who will rank high among those who have contributed to the scientific distinction of the nineteenth century. Every student of optics knows M. Fizeau's beautiful experimental method of determining the velocity of light; but not so many are aware of the other re-

markable researches by which he has partially answered some of the most difficult questions as to the relation of matter to ether, which are perplexing the best physical investigators of the time.

Born in 1819, Fizeau was only thirty years of age when his paper, "Sur une expérience relative à la vitesse de propagation de la lumière," appeared in the *Comptes rendus*. In this he put forward his plan of rotating a wheel having round its rim alternate teeth and spaces of equal width, so that these teeth and spaces should alternately intercept and allow to pass a beam of light from a source, and so adjusting the speed of rotation that the time occupied by the light in travelling from the wheel to a mirror and back again, should be equal to the time taken by the rim of the wheel to advance through a space equal to an integral number of times the width of a tooth or space. Curiously enough, the other experimental method of finding the velocity of light was described by Foucault in the very next volume of the *Comptes rendus*. In some respects the latter method—that of the revolving mirror—was even more striking than that of Fizeau. It allowed the velocity of light to be determined within an ordinary room, and, besides, enabled the question as to whether light travelled more or less quickly through a more refractive medium to be decided by direct experiment.

Another experiment of capital importance with which the name of Fizeau will ever be honourably associated is that by which he determined the amount of drift of light-waves in a transparent medium in motion. According to a theory given by Fresnel, the velocity of drift of ether-waves in a medium moving with velocity u is $(1 - 1/\mu^2)u$, where μ is the index of refraction of the medium. This conclusion of Fresnel was verified more lately by the experiments of Airy and Hoek, which proved, in opposition to the statement of Klinkerfues, that no change in the constant of aberration is observed when the tube of the observing telescope is filled with water. But it was tested directly by Fizeau in the most simple and beautiful manner. Two tubes were arranged side by side, and water was forced at a considerable speed (as much as seven metres per second) along one tube and back by the other, while a beam of light was split into two parts, which were sent round the tubes, one with the stream, the other against the stream, and then brought together again and tested for interference produced by the virtual difference of path traversed, arising from the motion of the water. The result gave exactly the formula quoted above, and has been confirmed by very careful experiments made comparatively recently by Michelson and Morley.

Fizeau made some notable observations on the number of interference bands observable with approximately homogeneous light, and, in conjunction with Foucault, carried out a most important series of observations on the light in different parts of the field of illumination in interference experiments. The method consisted in applying the spectroscope to examine the light taken from a narrow part of the field parallel to the bands, and proved *inter alia* that there is really interference in that region of the field which seems to be uniformly illuminated in consequence of overlapping produced by want of perfect homogeneity of the light.

One very important recent result of such observations has been to show that the detection of interference is limited only by the resolving power of the spectroscope employed, and that the usual inference as to the regularity of the vibrations in a source of light is unjustifiable.

Like Joule in this country, Fizeau carried on scientific research largely from his own private resources; and by a long series of most valuable papers published in the Memoirs of the French Academy and elsewhere, he has earned the gratitude of his countrymen and the world. But his most enduring memorial will doubtless be his determination by simple laboratory apparatus of the velocity of light (a velocity sufficient to enable the earth's path round the sun to be traversed in about twenty-six minutes !), and with his great colleague Foucault he will be held in honoured remembrance so long as men study the science of optics.

Fizeau was elected a Foreign Member of the Royal Society in 1875, and he received the Rumford Medal of the Society in recognition of his scientific work.

A. Gray.

NOTES.

The monument to Lobachevsky, erected at Kazan, in a square which bears the name of the great geometer, was unveiled on September 13, in the presence of the Bishop of Kazan, the Governor of the province, the University, the local Physical and Mathematical Society, and a great number of sympathisers. The Mayor of Kazan made a statement as to the funds raised for the erection of the monument. Prof. Suvoroff referred to the scientific work of Lobachevsky in mathematics and physics, and Prof. Vasilieff spoke of the great geometer as one whose life was worthy of emulation, and as an energetic worker for spreading scientific knowledge. In the evening the Physical and Mathematical Society held a special commemoration meeting before a distinguished gathering of visitors of both sexes.

A series of *fêtes* have been celebrated at Alais, in the centre of the great mulberry and silkworm district of France, in commemoration of the services rendered by Pasteur to sericulture. A statue of Pasteur was unveiled during the celebrations; and, on Saturday last, a solemn service was celebrated in the cathedral in commemoration of the first anniversary of his death, which occurred on September 28, 1895.

The Harveian oration is to be delivered before the Royal College of Physicians, on October 19, by Dr. J. Frank Payne.

It is proposed to establish an International Botanical Station at Palermo, under the superintendence of Prof. Borzi, who desires the co-operation of botanists of all countries.

Dr. A. Zimmermann has been appointed botanist to the section of the Botanic Garden, Buitenzorg, Java, devoted to the cultivation of coffee.

The Graefe gold medal, which is awarded by the German Ophthalmological Society every ten years, has this year been awarded to Prof. Theodore Leber, of Heidelberg, in recognition of his work on inflammation. Prof. von Helmholtz was the first to receive the medal, the award being made for his discovery of the ophthalmoscope, and his treatise on physiological optics.

A gas exposition, beginning on January 25, 1897, is to be held for two weeks in the Madison Square Garden, New York. The object of the exposition, according to the prospectus, is to bring together a collection of gas apparatus and appliances of every description, for the purpose of affording the general public and the gas engineer an opportunity to study the developments that have taken place in the gas industry during recent years.

The French Medical Press Association is organising a memorial festival in honour of the jubilee of the discovery of anæsthesia. The festival will take place in Paris, on October 18 and following days. The programme includes a ceremonial meeting at the Sorbonne, a banquet, and a special performance at one of the theatres. A suitable commemoration of the event is being arranged in Boston (Mass.), where the first

surgical operation under ether was performed on October 16, 1846. The Society of Anæsthetists, of London, is also taking steps to celebrate the occasion in a fitting manner.

The Peary expedition has returned to Sydney, Cape Breton, from Greenland, but without the great meteorite which it hoped to bring back. This enormous block of metal, which Lieut. Peary set out to fetch, weighs about forty tons, and is situated on an island twenty miles inside Cape York. The jackscrews designed to lift the mass upon shipboard proved not to be strong enough, so another journey will have to be undertaken to secure it. Meanwhile we trust that the Esquimaux, who have used the meteorite as a source of workable iron for many years, will not greatly reduce the mass before another attempt is made to remove it. In spite of this disappointment, the members of the expedition have not returned empty-handed; for their collections and observations appear to be valuable and varied.

The meeting of the American Public Health Association was held at Buffalo, September 15–18, the President, Dr. Eduardo Licéaga, of Mexico, in the chair. Delegates, thirty-five in all, were present from nearly every State in Mexico, from most of the United States, and from Canada. The work of sanitation thus received an impetus throughout the American continent; and such diseases as yellow fever, small-pox, diphtheria, &c., are waning under the vigilant efforts of the combined army of health officers. Diligent attention to business, and rigid enforcement of time limits, enabled the Association to complete a long and valuable programme of reports and papers, besides adopting several important resolutions. As to the place of meeting next year, the advisory council recommended Toronto. Motions were made to substitute Nashville and Philadelphia, and the final vote favoured the latter, which will accordingly be the place of the next (being the twenty-fifth) meeting of the Association. The officers elected are:—President, Dr. H. B. Hornbeck, of Charleston, S.C.; first Vice-President, Dr. Peter H. Bryce, of Toronto, Canada; second Vice-President, Dr. Ernest Wende, of Buffalo, N.Y.; Treasurer, Dr. Henry H. Holton, of Brattleboro', Vt.

We regret to record the death of Sir John Erichsen, the distinguished surgeon, at the age of seventy-eight. He was elected a Fellow of the Royal Society in 1876, and since 1887 had been President of University College, London.

Sir George M. Humphry, F.R.S., Professor of Surgery in the University of Cambridge, died on Thursday last, and by his death the University is deprived of one through whose exertions the medical school has been brought to the present high position. He became Professor of Anatomy in the University in 1866, and Professor of Surgery in 1883. His life affords an instance of the manner in which the development of a subject is dependent upon the bearing of University authorities towards it. When he was appointed to the chair in the University, he set to work, in conjunction with the late Sir George Paget, with the object of placing the study of medicine and surgery in a more prominent and satisfactory position. To quote the *Times*: "It was a task of great difficulty, for, although as far back as 1851 the Natural-Science Tripos had been in existence, yet it attracted but a handful of students for the first twenty years. The first real impetus given to the work was when some of the colleges recognised the Natural-Science Tripos as one avenue to a fellowship. The standard of the examinations, both for the Tripos and for medical degrees, was raised, examiners not connected with the University were appointed, and open scholarships for Natural Science were offered. The result is that at the present time the Natural-Science Tripos attracts more students than any other of the honour examinations in the University, the medical school is one of the largest in the country, and the medical degrees of the University are held in the highest estimation by the profession. He has left behind him an array of excellent professors and teachers, and has placed the study of medicine and surgery in the front rank at the University. His exertions entitle him to be regarded as one of the greatest benefactors to the University in modern times." His chief scientific work was in comparative anatomy, to which branch of knowledge he made some important contributions. Among his best-known works are "A Treatise on the Human Skeleton," 1858; "On Myology," 1872; "Old Age, and Changes incidental to it," 1889.

With reference to the recent disastrous gales and torrential rainfall over the British Islands, the *Weekly Weather Report* of September 26 shows that the changes brought about in barometric pressure were very great, amounting to considerably over an inch in twenty-four hours at many places. The rainfall was much in excess in all districts, especially in the western parts of the country; falls exceeding an inch in twenty-four hours have been reported on several days. The total rainfall since the beginning of the year is still below the average, except in the north of Scotland and the north of Ireland. The greatest deficiency is in the south-west of England, where it amounts to nearly seven inches.

A lunar bow, in which the various prismatic colours could be distinguished without difficulty, was observed at Portmadoc, North Wales, last Sunday evening, by Mr. Walter Williams, who has sent us a description of the phenomenon. The time at which the bow was seen was 9.40 p.m. The colours appeared on the western edge of a dark rain-cloud, which was moving rapidly towards the east. This cloud was apparently very much in advance of another thin cloud, of pearly whiteness, surrounding the moon's disc; nevertheless the two clouds seemed continuous, and the soft silky whiteness of the one formed a sharp contrast to the coloured bow on the edge of the other. There were no more clouds in the immediate vicinity of the moon. The bow was visible for a length about twelve times greater than the moon's apparent diameter. Violet was the innermost colour, and there was a sharp contrast between it and the white cloudiness. The whole phenomenon only lasted four minutes.

In a valuable memoir recently published in the *Annali* of the Central Meteorological Office of Rome, Prof. Arcidiacono describes the Syracuse earthquake of April 13, 1895, which disturbed the whole of the south-east corner of Sicily. The centre of the epicentral area is at the village of Vizzini, and its longer axis lies along a line joining this place with Cape Passero. It is interesting to notice that this line coincides nearly with the axis of the ridge of Monte Lauro, and also joins the two principal volcanic centres (now extinct) of the Val di Noto. At the epicentre the intensity was 9, according to the Rossi-Forel scale; in other words, the shock was sufficiently strong to damage buildings, but not to destroy them entirely. On the map which illustrates his paper, Prof. Arcidiacono shows the course of eight isoseismal lines, and, using the method of Dutton and Hayden, estimates the depth of the seismic focus to be about 7·4 km.

In the *Revue Scientifique* (No. 11) will be found the communication made by M. Stokvis to the International Colonial Institute on the question of colonisation in tropical regions. The author speaks strongly in favour of successful colonisation by Europeans in low latitudes, and brings evidence together showing that with due regard to hygiene the European is practically as well off as the native. The conclusions which he eventually arrives at are: (1) That the establishment and prosperity of European colonies, whether they be for purposes of "exploitation" or agriculture, are perfectly possible in both

high and low tropical regions. (2) In the question of colonisation, tropical temperatures and the race of the colonist play only secondary *rôles*. (3) Colonisation on a large scale—that is colonisation of the masses—ought to be stopped.

A NEW volume of the late Baron Uslar's great work on the languages of the Caucasian mountaineers has just been issued at Tiflis, by the Department of Education. It is devoted to the Kyurin language. The Kyurins are a small stem, inhabiting the banks of the Samur river, in the north of the Daghestan plateau. For a long time they were under the rule of the khans of Derbent, Kuba, or Kazikumukh; but in the second half of the last century a separate Kyurin khanate came into existence, and maintained itself up to 1866, when it was conquered by the Russians. The Kyurin language, which has many sub-branches, must be considered as an independent linguistic unit, while its pronunciation varies with nearly every separate village. The first part of Baron Uslar's work contains a description of the leading features of the language and its grammar; while the second part is a dictionary of Kyurin words.

The current number of the *Zoologist* contains an interesting article, by Mr. A. Holte Macpherson, on "Some Observations on the Note of the Cuckoo." During the spring and early summer of the present year the author took every available opportunity of listening to the cuckoo, and enlisted in his service many friends to do the same, his purpose being to determine, if possible, the pitch of the bird's voice, and the duration of the interval between the notes of its call. An analysis of the reports in his hands shows that when the bird is in full song the interval is usually greater than the minor third, and is to all intents and purposes a full major third. Not infrequently the bird utters three notes. At Haileybury, on June 7, it was heard to sing E flat, D C two or three times, then it omitted the middle note, singing a minor third. Two other birds are reported to have sung F F C and F, D flat, and C, respectively. As regards the pitch, out of hundreds of recorded calls during the period when the bird was in good voice, the upper note in nineteen cases out of twenty was from F to E flat, and the lower note from D to B. The author comes to the conclusion that the average call is E and C in the middle of the piano.

WITH its current issue, our contemporary, *Science Progress*, enters upon a new phase of its existence. It has been enlarged, and will in future appear quarterly, instead of monthly, at a slightly increased price.

Bulletin No. 57 of the Experiment Station of the Kansas State Agricultural College, Manhattan, is occupied by a descriptive list of "Kansas Weeds," accompanied by upwards of twenty plates of drawings of the leaves or other characteristic organs.

Timehri (June), the journal of the Royal Agricultural and Commercial Society of British Guiana, contains the following scientific contributions: "Multiple Evaporation," by W. P. Abell; "Queer Homes" (an account of nests built in peculiar places), by C. A. Lloyd; "Note on Berbice Bats," by Dr. C. G. Young; "India-Rubber Collection at Para," by J. A. Coelho. In addition to the foregoing, there are a number of articles of commercial interest.

MR. BERNARD QUARITCH has sent us his catalogue, dated September, containing a great many works relating to mathematics, microscopy, mountaineering, naval sciences, ornithology, palæontology, travels and zoology. Among the books mentioned we notice a complete set of the "Philosophical Transactions of the Royal Society," with general indexes; a set of the "Transactions of the Linnean Society," from 1791 to 1891; the "Proceedings and Journal of the Linnean Society," from 1838 to 1895; and the "Proceedings of the Zoological Society," from 1830 to 1894.

A CATALOGUE of meteorites in the collection of the American Museum of Natural History, New York, by Mr. E. O. Hovey, has been received. The collection consists of fifty-five slabs fragments and complete objects, representing twenty-six falls and finds. The source of each specimen, also the dates of discovery, and the individual weights in grams, is given in the catalogue, which should be of interest and service to many visitors to the museums and others.

WE have received the *Bulletin of Miscellaneous Information* of the Royal Botanic Gardens, Trinidad, for July. Among the "Natural History Notes" is a very interesting account of the life-history of the parasol ants, *Atta cephalotes* and *octospinosa*, with drawings of the various forms—the male, queen, soldier, worker major, worker minor, nurse, and gardener. Mr. J. H. Hart, the Superintendent, confirms the statement of Belt that these ants carry vegetable matter into their nests, not as food, but as a material on which to grow the fungi on which they feed. The destruction caused by various species of parasol ant in the Western Tropics is a matter of very serious importance to the agricultural industries.

WE have received the *Bulletin Meteorologique et Seismique de l'Observatoire Imperial de Constantinople* for February of this year. In this is given a list of the earthquakes observed during this month in the East, and more especially those occurring in the Ottoman Empire. The number seems to be considerable, no less than twenty-nine being described. The meteorological observations for this month are also given, the Director of the Observatory, Salib Feky, adding a *résumé* and his usual monthly *revue climatologique*.

THE additions to the Zoological Society's Gardens during the past week include two Bonnet Monkeys (*Macacus sinicus*, ♀ ♀) from India, presented by Mrs. Strutt; a Macaque Monkey (*Macacus cynomolgus*, ♀) from India, presented by Mr. J. Laverock; a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Miss M. E. Clarke; a —— Squirrel (*Sciurus* sp. ?) from Monravia, West Africa, presented by Mr. Ellis Edwards; an Orange-cheeked Amazon (*Chrysotis autumnalis*) from Honduras, presented by Mr. Baratti; a Common Heron (*Ardea cinerea*), British, presented by Mr. E. J. Poyser; four Montague's Harriers (*Circus cineraceus*), British, presented by Mr. W. J. Laidlay; three Pin-tailed Sand Grouse (*Pterocles alchata*) from Spain, presented by Mr. G. P. Torrens; six Rough Terrapins (*Clemmys punctularia*) from Para, presented by Dr. E. A. Goeldi; a short-tailed Wallaby (*Halmaturus brachyurus*) from Australia, deposited; two Ruffs (*Machetes pugnax*), British, purchased; an African Lepidosiren (*Lepodosiren annectans*) from West Africa, received in exchange.

OUR ASTRONOMICAL COLUMN.

THE SOLAR ROTATION.—In the August number of the *Astrophysical Journal* there is a brief summary of the work being done at John Hopkins University by Mr. Lewis Jewell. These researches dealt with the question of the solar rotation, and Mr. Jewell's recent work in measuring a large number of lines in photographs of the solar spectrum has brought out, as is stated, a new and remarkable peculiarity in the law of the solar rotation. The following is a brief extract of the note in question. "It is found that there is a difference of several days in the rotation periods of the outer and inner portions of the sun's atmosphere, the period increasing as the photosphere is approached. The measures also show the equatorial acceleration to be much the greatest for the outer portions of the atmosphere. At the lower levels the acceleration is small, there being little difference in the periods for different latitudes. It is further found that the carbon (cyanogen) lines and the shaded portions of H and K take their rise very low down in the solar atmosphere. Mr. Jewell is at present engaged upon the reduction of the measures."

A NEW SPECTROSCOPIC BINARY.—Prof. E. C. Pickering, in Circular (No. 11) of the Harvard College Observatory, dated August 31, informs us that Prof. Solon I. Bailey has found μ^1 Scorpii to be a spectroscopic binary. This star is $-37°\cdot11033$ = S.M.P. 5794; its approximate position for 1900 is R.A. 16h. 45·1m. Decl. $-37°$ 53', its photometric magnitude being 3·26. A neighbouring star μ^2 Scorpii follows about 28s., is 1'·7 north, with a photometric magnitude of 3·74. As these two stars were close alongside on the photographic plate, a comparison was easy. The spectrum of the first-named is described as of the first type, with the additional lines characteristic of the Orion stars. In some of the spectra they are scarcely distinguishable, while in others the lines of the first are broad and hazy, some, more faint, being distinctly double. Mrs. Fleming, who examined these plates in 1894, recorded these lines as being double, but the plates were put away for further examination, and subsequently overlooked. An examination of the three plates sent to Cambridge showed that the lines in the spectrum of μ^1 were single on October 2, 1892, wide and hazy on July 20, 1894, and double on July 31, 1894. A more minute examination has shown that the changes are very rapid, a period of 35 hours and a nearly circular orbit having been deduced by Prof. Bailey from a discussion of fifty-two photographs. An independent discussion at Harvard gives the average period of 34h. 42·5m., with an error of less than 6s. Ten observed times, when the lines were single, are represented with an average deviation of 38 minutes each; the maximum deviation is less than an hour. Other stars of this class, only two of which are already known, are ζ Ursæ Majoris and β Aurigæ. The former was discovered by Prof. Pickering in 1889; it has a period of 52 days, and is irregular. The latter we owe to Miss A. C. Maury; the period of this is regular, and is of nearly four days in length.

THE VARIABLE STAR Z HERCULIS.—A point of great importance, but not sufficiently attended to by those who compute variable star observations, is referred to by Mr. Paul S. Yendell in *Astronomical Journal*, No. 20. It is well known that outstanding observations—that is, those which seem apparently to be incorrect—are generally discarded, as leading to erroneous results in the final reduction. This is often done, for instance, when a curve is drawn through the points, representing the observations, and finally smoothed to include, as near as possible, all the data. This smoothing is carried, in some cases, to a considerable extent; in fact so far that a slight hump in the curve is looked upon as evidently due to errors of observation, and consequently smoothed over, and therefore lost so far as the results are concerned. Mr. Yendell refers to a similar "smoothing" by the rejection of observations which do not bear out the hypothesis of the calculated orbit. In the note in question, he takes the case of the four observations, made by Muller and Kempf, of the variable star Z Herculis, for the Potsdam Photometric Durchmusterung. The first and last observations satisfy the elements of Hartwig, but these latter are not in accord with observations made by Yendell in 1895. Duner's elements, on the other hand, are found to satisfy the observations of 1894 and 1895, but not those made at an earlier date at Potsdam. Mr. Yendell thus concludes that the star's period must evidently be variable, though, as he says, the character and value of the variation cannot at present be determined. He objects, however, strongly to Prof. Duner's allusion to one of his (Yendell's) observations as "evidently erroneous." This observation, as Yendell remarks, "happens to be one of the best defined and best observed of the entire series, and entirely free from any suspicion of prepossession, as is indicated by the weight attached to it."

The value of an apparently outstanding observation is further instanced by Yendell in the case of the star U Pegasi, observed by him in 1894, which he had been inclined to pass over lightly as "hopelessly discordant," but which proved in reality to have "contained the key to the whole enigma of the star's period." Other instances might be given of similar cases; but sufficient has been said to draw attention to the fact that the light of variable stars is of a more variable nature than is at present supposed. Recent observations and reductions have shown that the curves representing variability of some stars is not a simple rise to maximum and fall to minimum, but the curvature varies both on the upward and downward side of the light curve to no slight extent. Cases of this kind seem to point to the suggestion that more than two bodies are involved.

THE BRITISH ASSOCIATION.

SECTION H.

ANTHROPOLOGY.

OPENING ADDRESS BY ARTHUR J. EVANS, PRESIDENT OF THE SECTION.

"*The Eastern Question*" *in Anthropology.*

TRAVELLERS have ceased to seek for the "Terrestrial Paradise," but, in a broader sense, the area in which lay the cradle of civilised mankind is becoming generally recognised. The plateaus of Central Asia have receded from our view. Anthropological researches may be said to have established the fact that the white race, in the widest acceptation of the term, including, that is, the darker-complexioned section of the South and West, is the true product of the region in which the earliest historic records find it concentrated. Its "Area of Characterisation" is conterminous, in fact, with certain vast physical barriers due to the distribution of sea and land in the latest geological period. The continent in which it rose, shut in between the Atlantic and the Indian Oceans, between the Libyan Desert, and what is now Sahara, and an icier Baltic stretching its vast arms to the Ponto-Caspian basin, embraced, together with a part of anterior Asia, the greater part of Europe, and the whole of Northern Africa. The Mediterranean itself—divided into smaller separate basins, with land bridges at the Straits of Gibraltar, and from Sicily and Malta to Tunis—did not seriously break the continuity of the whole. The English Channel, as we know, did not exist, and the old sea-coast of what are now the British Islands, stretching far to the west, is, as Prof. Boyd Dawkins has shown, approximately represented by the hundred-fathom line. To this great continent Dr. Brinton, who has so ably illustrated the predominant part played by it in isolating the white from the African black and the yellow races of mankind, has proposed to give the useful and appropriate name of "Eurafrica." In "Eurafrica," in its widest sense, we find the birthplace of the highest civilisations that the world has yet produced, and the mother country of its dominant peoples.

It is true that later geological changes have made this continental division no longer applicable. The vast land area has been opened to the east, as if to invite the Mongolian nomads of the Steppes and Tundras to mingle with the European population; the Mediterranean bridges, on the other hand, have been swept away. Asia has advanced, Africa has receded. Yet the old underlying connection of the peoples to the north and south of the Mediterranean basin seems never to have been entirely broken. Their inter-relations affect many of the most interesting phenomena of archæology and ancient history, and the old geographical unity of "Eurafrica" was throughout a great extent of its area revived in the great political system which still forms the basis of civilised society, the Roman Empire. The Mediterranean was a Roman lake. A single fact brings home to us the extent to which the earlier continuity of Europe and North Africa asserted itself in the imperial economy. At one time, what is now Morocco and what is now Northumberland, with all that lay between them on both sides of the Pyrenees, found their administrative centre on the Mosel.

It is not for me to dwell on the many important questions affecting the physiological sides of ethnography that are bound up with these old geographical relations. I will, however, at least call attention to the interesting, and in many ways original, theory put forward by Prof. Sergi in his recent work on the "Mediterranean Race."

Prof. Sergi is not content with the ordinary use of the term "White Race." He distinguishes a distinct "brown" or "brunette" branch, whose swarthier complexion, however, and dark hair bear no negroid affinities, and are not due to any intermixture on that side. This race, with dolichocephalic skulls, amongst which certain defined types constantly repeat themselves, he traces throughout the Mediterranean basin, from Egypt, Syria, and Asia Minor, through a large part of Southern Europe, including Greece, Italy, and the Iberic peninsula, to the British islands. It is distributed along the whole of North Africa, and, according to the theory propounded, finds its original centre of diffusion somewhere in the parts of Somaliland.

It may be said at once that this grouping together into a consistent system of ethnic factors spread over this vast yet inter-related area—the heart of "Eurafrica"—presents many

attractive aspects. The ancient Greek might not have accepted kinship even with "the blameless Ethiopian," but those of us who may happen to combine a British origin with a Mediterranean complexion may derive a certain ancestral pride from remote consanguinity with Pharaoh. They may even be willing to admit that "the Ethiopian" in the course of his migrations has done much to "change his skin."

In part, at least, the new theory is little more than a re-statement of an ethnographic grouping that commands a general consensus of opinion. From Thurnam's time onwards we have been accustomed to regard the dolichocephalic type found in the early Long Barrows, and what seem to have been the later survivals of the same stock in our islands, as fitting on to the Iberian element in South-western Europe. The extensive new materials accumulated by Dr. Garson have only served to corroborate these views, while further researches have shown that the characteristic features of the skeletons found in the Ligurian caves, at Cro Magnon and elsewhere in France, are common to those of a large part of Italy, Sicily, and Sardinia, and extend not only to the Iberic group, but to the Guanche interments of the Canary Islands.

The newly correlated data unquestionably extend the field of comparison; but the theories as to the original home of this "Mediterranean Race" and the course of its diffusion may be thought to be still somewhat lacking in documentary evidence. They remind us rather too closely of the old "Aryan" hypothesis, in which we were almost instructed as to the halting places of the different detachments as they passed on their way from their Central Asian cradle to rearrange themselves with military precision, and exactly in the order of their relationship, in their distant European homes. The existing geological conditions are made the basis of this migratory expansion from Ethiopia to Ireland; parallel streams move through North Africa and from Anatolia to Southern Europe. One cardinal fact has certainly not received attention, and that is, that the existing evidence of this Mediterranean type dates much further back on European soil than even in ancient Egypt.

Prof. Sergi himself has recognised the extraordinary continuity of the cranial type of the Ligurian caves among the modern population of that coast.

But this continuity involves an extreme antiquity for the settlement of the "Mediterranean Race" in North-western Italy and Southern France. The cave interments, such as those of the Finalese, carry back the type well into Neolithic times. But the skeletons of the Baoussé Roussé caves, between Mentone and Ventimiglia, which reproduce the same characteristic forms, take us back far behind any stage of culture to which the name of Neolithic can be properly applied.

The importance of this series of interments is so unique, and the fulness of the evidence so far surpasses any other records immediately associated with the earliest remains of man, that even in this brief survey they seem to demand more than a passing notice.

So much, at least, must be admitted on all hands: an earlier stage of culture is exhibited in these deposits than that which has hitherto been regarded as the minimum equipment of the men of the later Stone Age. The complete absence of pottery, of polished implements, of domesticated animals—all the more striking from the absolute contrast presented by the rich Neolithic cave burials a little further up the same coast—how is it to be explained? The long flint knives, the bone and shell ornaments, might, indeed, find partial parallels among Neolithic remains; but does not, after all, the balance of comparison incline to that more ancient group belonging to the "Reindeer Period" in the South of France, as illustrated by the caves of La Madeleine, Les Eyzies and Solutré?

It is true that, in an account of the interments found in 1892 in the Barma Grande Cave, given by me to the Anthropological Institute, I was myself so prepossessed by the still dominant doctrine that the usage of burial was unknown to Palæolithic man, and so overpowered by the vision of the yawning hiatus between him and his Neolithic successor, that I failed to realise the full import of the evidence. On that occasion I took refuge in the suggestion that we had here to deal with an earlier Neolithic stratum than any hitherto recorded. "Neolithic," that is, without the Neolithic.

But the accumulation of fresh data, and especially the critical observations of M. d'Acy and Prof. Issel, have convinced me that this intermediate position is untenable. From the great depth below the original surface, of what in all cases seem to have been homogeneous quaternary deposits, at which the human remains were found, it is necessary to suppose, if the interments took place at a later period, that pits in many cases from 30 to 40 feet deep must have been excavated in the cave earth. But nothing of the kind has been detected, nor any intrusion of extraneous materials. On the other hand, the gnawed or defective condition of the extremities in several cases points clearly to superficial and imperfect interment of the body; and in one case parts of the same core from which flints found with the skeleton had been chipped were found some metres distant on the same floor level. Are we, then, to imagine that another pit was expressly dug to bury these?

In the case of a more recently discovered and as yet unpublished interment, at the excavation of which I was so fortunate as to assist, the superficial character of the deposit struck the eye. The skeleton, with flint knife and ochre near, decked out with the usual shell and deer's tooth ornaments, lay as if in the attitude of sleep, somewhat on the left side. The middle of the body was covered with a large flat stone, with two smaller ones lying by it, while another large stone was laid over the feet. The left arm was bent under the head as if to pillow it, but the extremities of the right arm and the toes were suggestively deficient: the surface covering of big stones had not sufficiently protected them. The stones themselves seem in turn to have served as a kind of hearth, for a stratum of charred and burned bones about 45 cm. thick lay about them.

Is it reasonable to suppose that a deposit of this kind took place at the bottom of a pit over 20 feet deep, left open an indefinite time for the convenience of roasting venison at the bottom?

A rational survey of the evidence in this as in the other cases leads to the conclusion that we have to deal with surface burial, or, if that word seems too strong, with simple "seposition"—the imperfect covering with handy stones of the dead bodies as they lay in the attitude of sleep on the then floor of the cavern. In other words, they are *in situ* in a late quatenary deposit, for which Prof. Issel has proposed the name of "Meiolithic."

But if this conclusion is to hold good, we have here on the northern coast of the Mediterranean evidence of the existence of a late Palæolithic race, the essential features of which, in the opinion of most competent osteological inquirers, reappear in the Neolithic skeletons of the same Ligurian coast, and still remain characteristic of the historical Ligurian type. In other words, the "Mediterranean Race" finds its first record in the West; and its diffusion, so far from having necessarily followed the lines of later geographical divisions, may well have begun at a time when the land bridges of "Eurafrica" were still unbroken.

There is nothing, indeed, in all this to exclude the hypothesis that the original expansion took place from the East African side. That the earliest homes of primæval man lay in a warm region can hardly be doubted, and the abundant discovery by Mr. Seton Karr in Somaliland of Palæolithic implements reproducing many of the most characteristic forms of those of the grottoes of the Dordogne affords a new link of connection between the Red Sea and the Atlantic littoral.

When we recall the spontaneous artistic qualities of the ancient race which has left its records in the carvings on bone and ivory in the caves of the "Reindeer Period," this evidence of at least partial continuity on the northern shores of the Mediterranean suggests speculations of the deepest interest. Overlaid with new elements, swamped in the dull, though materially higher, Neolithic civilisation, may not the old æsthetic faculties which made Europe the earliest-known home of anything that can be called human art, as opposed to mere tools and mechanical contrivances, have finally emancipated themselves once more in the Southern regions, where the old stock most survived? In the extraordinary manifestations of artistic genius to which, at widely remote periods, and under the most diverse political conditions, the later populations of Greece and Italy have given birth, may we not be allowed to trace the re-emergence, as it were, after long underground meanderings, of streams whose upper waters had seen the daylight of that earlier world?

But the vast gulf of time beyond which it is necessary to carry back our gaze in order to establish such connections will hardly permit us to arrive at more than vague probabilities. The practical problems that concern the later culture of Europe from Neolithic times onwards connect themselves rather with its relation to that of the older civilisations on the southern and eastern Mediterranean shores.

Anthropology, too, has its "Eternal Eastern Question." Till

within quite recent years, the glamour of the Orient pervaded all inquiries as to the genesis of European civilisation. The Biblical training of the northern nations prepared the ground. The imperfect realisation of the antiquity of European art; on the other hand, the imposing chronology of Egypt and Babylonia; the abiding force of classical tradition, which found in the Phœnician a *deus ex machinâ* for exotic importations; finally, the "Aryan Hypothesis," which brought in the dominant European races as immigrant wanderers from Central Asia, with a ready-made stock of culture in their wallets—these and other causes combined to create an exaggerated estimate of the part played by the East as the illuminator of the benighted West.

More recent investigations have resulted in a natural reaction. The primitive "Aryan" can be no longer invoked as a kind of patriarchal missionary of Central Asian culture. From d'Halloy and Latham onwards to Penka and Schrader an array of eminent names has assigned to him an European origin. The means by which a kindred tongue diffused itself among the most heterogeneous ethnic factors still remain obscure; but the stricter application of phonetic laws and the increased detection of loan-words has cut down the original "Aryan" stock of culture to very narrow limits, and entirely stripped the members of this linguistic family of any trace of a common Pantheon.

Whatever the character of the original "Aryan" stage, we may be very sure that it lies far back in the mists of the European Stone Age. The supposed common names for metals prove to be either a vanishing quantity or strikingly irrelevant. It may be interesting to learn on unimpeachable authority that the Celtic words for "gold" are due to comparatively recent borrowing from the Latin; but nothing is more certain than that gold was one of the earliest metals known to the Celtic races, its knowledge going back to the limits of the pure Stone Age. We are told that the Latin "ensis," "a sword," is identical with the Sanskrit "asi" and Iranian "ahi," but the gradual evolution of the sword from the dagger, only completed at a late period of the Bronze Age, is a commonplace of prehistoric archæology. If "ensis," then, in historical times an iron sword, originally meant a bronze dagger, may not the bronze dagger in its turn resolve itself into a flint knife?

The truth is that the attempts to father on a common Aryan stock the beginnings of metallurgy argue an astonishing inability to realise the vast antiquity of languages and their groups. Yet we know that, as far back as we have any written records, the leading branches of the Aryan family of speech stood almost as far apart as they do to-day, and the example of the Egyptian and Semitic groups, which Maspero and others consider to have been originally connected, leads to still more striking results. From the earliest Egyptian stela to the latest Coptic liturgy we find the main outlines of what is substantially the same language preserved for a period of some six thousand years. The Semitic languages in their characteristic shape show a continuous history almost as extensive. For the date of the diverging point of the two groups we must have recourse to a chronology more familiar to the geologist than the antiquary.

As importer of exotic arts into primitive Europe the Phœnician has met the fate of the immigrants from the Central Asian "Arya." The days are gone past when it could be seriously maintained that the Phœnician merchant landed on the coast of Cornwall, or built the dolmens of the North and West. A truer view of primitive trade as passing on by inter-tribal barter has superseded the idea of a direct commerce between remote localities. The science of prehistoric archæology, following the lead of the Scandinavian School, has established the existence in every province of local centres of early metallurgy, and it is no longer believed that the implements and utensils of the European Bronze Age were imported wholesale by Semites or "Etruscans."

It is, however, the less necessary for me to trace in detail the course of this reaction against the exaggerated claims of Eastern influence that the case for the independent position of primitive Europe has been recently summed up with fresh arguments, and in his usual brilliant and incisive style, by M. Salomon Reinach, in his "Mirage Orientale." For many ancient prejudices as to the early relations of East and West it is the trumpet sound before the walls of Jericho. It may, indeed, be doubted whether, in the impetuousness of his attack, M. Reinach, though he has rapidly brought up his reserves in his more recent work on primitive European sculpture, has not been tempted to occupy outlying positions in the enemy's country which will hardly be found tenable in the long run. I cannot myself, for instance, be brought to believe that the rude marble "idols" of the primitive Ægean population were copied on Chaldæan cylinders. I may have occasion to point out that the oriental elements in the typical higher cultures of primitive Europe, such as those of Mycenæ, of Hallstatt, and La Tène, are more deeply rooted than M. Reinach will admit. But the very considerable extent to which the early European civilisation was of independent evolution has been nowhere so skilfully focussed into light as in these comprehensive essays of M. Reinach. It is always a great gain to have the extreme European claims so clearly formulated, but we must still remember that the "Sick Man" is not dead.

The proofs of a highly developed metallurgic industry of home growth accumulated by prehistoric students *pari passu* over the greater part of Europe, and the considerable cultural equipment of its early population—illustrated, for example, in the Swiss Lake settlements—had already prepared the way for the more startling revelations as to the prehistoric civilisation of the Ægean world which have resulted from Dr. Schliemann's diggings at Troy, Tiryns, and Mycenæ, so admirably followed up by Dr. Tsountas.

This later civilisation, to which the general name of "Ægean" has been given, shows several stages, marked in succession by typical groups of finds, such as those from the Second City of Troy, from the cist-graves of Amorgos, from beneath the volcanic stratum of Thera, from the shaft-graves of Mycenæ, and again from the tombs of the lower town. Roughly, it falls into two divisions, for the earlier of which the culture illustrated by the remains of Amorgos may be taken as the culminating point, while the later is inseparably connected with the name of Mycenæ.

The early "Ægean" culture rises in the midst of a vast province extending from Switzerland and Northern Italy through the Danubian basin and the Balkan peninsula, and continued through a large part of Anatolia, till it finally reaches Cyprus. It should never be left out of sight that, so far as the earliest historical tradition and geographical nomenclature reach back, a great tract of Asia Minor is found in the occupation of men of European race, of whom the Phrygians and their kin—closely allied to the Thracians on the other side of the Bosphorus—stand forth as the leading representatives. On the other hand, the great antiquity of the Armenoid type in Lycia and other easterly parts of Asia Minor, and its priority to the Semites in these regions, has been demonstrated by the craniological researches of Dr. von Luschan. This ethnographic connection with the European stock, the antiquity of which is carried back by Egyptian records to the second millennium before our era, is fully borne out by the archæological evidence. Very similar examples of ceramic manufactures recur over the whole of this vast region. The resemblances extend even to minutiæ of ornament, as is well shown by the examples compared by Dr. Much from the Mondsee, in Upper Austria, from the earliest stratum of Hissarlik, and from Cyprus. It is in the same Anatolo Danubian area—as M. Reinach has well pointed out—that we find the original centre of diffusion of the "Svastika" motive in the Old World. Copper implements, and weapons, too, of primitive types, some reproducing Neolithic forms, are also a common characteristic, though it must always be remembered that the mere fact that an implement is of copper does not of itself necessitate its belonging to the earliest metal age, and that the freedom from alloy was often simply due to a temporary deficiency of tin. Cyprus, the land of copper, played, no doubt, a leading part in the dissemination of this early metallurgy, and certain typical pins and other objects found in the Alpine and Danubian regions have been traced back by Dr. Naue and others to Cypriote prototypes. The same parallelism throughout this vast area comes out again in the appearance of a class of primitive "idols" of clay, marble, and other materials, extending from Cyprus to the Troad and the Ægean islands, and thence to the pile settlements of the Alps and the Danubian basin, while kindred forms can be traced beyond the Carpathians to a vast northern Neolithic province that stretches to the shores of Lake Ladoga.

It is from the centre of this old Anatolo-Danubian area of primitive culture, in which Asia Minor appears as a part of Europe, that the new Ægean civilisation rises from the sea. "Life was stirring in the waters." The notion that the maritime enterprise of the Eastern Mediterranean began on the exposed and comparatively harbourless coast of Syria and Palestine can

no longer be maintained. The island world of the Ægean was the natural home of primitive navigation. The early sea-trade of the inhabitants gave them a start over their neighbours, and produced a higher form of culture, which was destined to react on that of a vast European zone—nay, even upon that of the older civilisations of Egypt and Asia.

The earlier stage of this Ægean culture culminates in what may conveniently be called the Period of Amorgos from the abundant tombs explored by Dr. Dümmler and others in that island. Here we already see the proofs of a widespread commerce. The ivory ornaments point to the South; the abundance of silver may even suggest an intercourse along the Libyan coast with the rich silver-producing region of South-eastern Spain, the very ancient exploitation of which has been so splendidly illustrated by the researches of the brothers Siret. Additional weight is lent to this presumption by the recurrence in these Spanish deposits of pots with rude indications of eyes and eyebrows, recalling Schliemann's owl-faced urns; of stone "idols," practically identical with those of Troy and the Ægean islands, here too associated with marble cups of the same simple forms; of triangular daggers of copper and bronze, and of bronze swords which seem to stand in a filial relation to an "Amorgan" type of dagger. In a former communication to this Section I ventured to see in the so-called "Cabiri" of Malta—very far removed from any Phœnician sculpture—an intermediate link between the Iberian group and that of the Ægean, and to trace on the fern-like ornaments of the altar-stone a comparison with the naturalistic motives of proto-Mycenæan art, as seen, for instance, on the early vases of Thera and Therasia.

A Chaldæan influence cannot certainly be excluded from this early Ægean art. It reveals itself, for instance, in indigenous imitations of Babylonian cylinders. My own conclusion that the small marble figures of the Ægean deposits, though of indigenous European lineage, were in their more developed types influenced by Istar models from the East, has since been independently arrived at by the Danish archæologist, Dr. Blinkenburg, in his study on præ-Mycenæan art.

More especially the returning-spiral decoration, which in the "Amorgan Period" appears upon seals, rings, bowls, and caskets of steatite, leads us to a very interesting field of comparison. This motive, destined to play such an important part in the history of European ornament, is absent from the earlier products of the great Anatolo-Danubian province. As a European design it is first found on these insular fabrics, and it is important to observe that it first shows itself in the form of reliefs on stone. The generally accepted idea, put forward by Dr. Milchhöfer, that it originated here from applied spirals on metal work is thus seen to be bereft of historical justification. At a somewhat later date we find this spiraliform motive communicating itself to the ceramic products of the Danubian region, though from the bold relief in which it sometimes appears, a reminiscence of the earlier steatite reliefs seems still traceable. In the late Neolithic pile-station of Butmir, in Bosnia, this spiral decoration appears in great perfection on the pottery, and is here associated with clay images of very advanced fabric. At Lengyel, in Hungary, and elsewhere, we see it applied to primitive painted pottery. Finally, in the later Hungarian Bronze Age it is transferred to metal work.

But this connection—every link of which can be made out—of the lower Danubian Bronze Age decoration with the Ægean spiral system—itself much earlier in origin—has a very important bearing on the history of ornament in the North and West. The close relation of the Bronze Age culture of Scandinavia and North-western Germany with that of Hungary is clearly established, and of the many valuable contributions made by Dr. Montelius to prehistoric archæology, none is more brilliant than his demonstration that this parallelism of culture between the North-west and South-east owes its origin to the most ancient course of the amber trade from the North Sea shores of Jutland by the valley of the Elbe and Moldau to the Danubian Basin. As Dr. Montelius has also shown, there was, besides, a western extension of this trade to our own islands. If Scandinavia and its borderlands were the source of amber, Ireland was the land of gold. The wealth of the precious metal there is illustrated by the fact that, even as late as 1796, the gold washings of County Wicklow amounted to 10,000*l.* A variety of evidence shows a direct connection between Great Britain and Scandinavia from the end of the Stone Age onwards. Gold diadems of unquestionably British—probably Irish—fabric have been found in Seeland and Fünen, and from the analysis of early gold ornaments it clearly results that it was from Ireland rather than the Ural that Northern and Central Europe was supplied. Mr. Coffey, who has made an exhaustive study of the early Irish monuments, has recently illustrated this early connection by other comparisons, notably the appearance of a design which he identifies with the early carvings of boats on the rocks of Scandinavia.

This prolongation of the Bronze Age trade route—already traced from the Middle Danube—from Scandinavia to Ireland, ought it to be regarded as the historic clue to the contemporary appearance of the spiral motive in the British Islands? Is it to this earlier intercourse with the land of the Vikings that we must ascribe the spiral scrolls on the slabs of the great chambered barrows of the Irish Bronze Age—best seen in the most imposing of them all, before the portal and on the inner chambers of New Grange?

The possibility of such a connection must be admitted; the probability is great that the contemporary appearance of the spiraliform ornament in Ireland and on the continent of Europe is due to direct derivation. It is, of course, conceivable that such a simple motive as the returning spiral may have originated independently in various parts of Europe, as it did originate in other parts of the world. But anthropology has ceased to content itself with the mere accumulation of sporadic coincidences. It has become a historic study. It is not sufficient to know how such and such phenomena *may* have originated, but how, as a matter of fact, they *did*. Hence in the investigation of origins and evolution the special value of the European field where the evidence has been more perfectly correlated and the continuous records go further back. An isolated example of the simple volute design belonging to the "Reindeer Period" has been found in the grotto of Arudy. But the earliest cultural strata of Europe, from the beginning of the Neolithic period onwards, betray an entire absence of the returning spiral motive. When we find it later propagating itself as a definite ornamental system in a regular chronological succession throughout an otherwise inter-related European zone, we have every right to trace it to a common source.

But it does not therefore follow that the only alternative is to believe that the spiral decoration of the Irish monuments necessarily connects itself with the ancient stream of intercourse flowing from Scandinavia.

We have to remember that the Western lands of gold and tin were the goals of other prehistoric routes. Especially must we bear in mind the early evidence of intercourse between the British Isles and the old Iberic region of the opposite shores of the continent. The derivation of certain forms of Bronze Age types in Britain and Ireland from this side has already been demonstrated by my father, and British or Irish bronze flat axes with their characteristic ornamentation have in their turn been found in Spain as well as in Denmark. The peculiar technique of certain Irish flint arrowheads of the same period, in which chipping and grinding are combined, is also characteristic of the Iberian province, and seems to lead to very extended comparisons on the Libyan side, recurring as it does in the exquisite handiwork of the non-Egyptian race whose relics Mr. Petrie has brought to light at Nagada. In prehistoric Spanish deposits, again, are found the actual wallet-like baskets with incurving sides, the prototypes of a class of clay food-vessels which (together with a much wider distribution) are of specially frequent occurrence in the British Isles as well as the old Iberian area.

If the spiral decoration had been also a feature of the Scandinavian rock carvings, the argument for derivation from that side would have been strong. But they are not found in them, and, on the other hand, the sculptures on the dolmens of the Morbihan equally show certain features common to the Irish stone chambers, including the primitive ship figure. The spiral itself does not appear on these; but the more the common elements between the Megalithic piles, not only of the old Iberian tract on the mainland, including Brittany, but in the islands of the West Mediterranean basin, are realised, the more probable it becomes that the impulse came from this side. The prehistoric buildings of Malta, hitherto spoken of as "Phœnician temples," which show in their primitive conception a great affinity to the Megalithic chambers of the earliest British barrows, bear witness on this side to the extension of the Ægean spiral system in a somewhat advanced stage, and accompanied, as at New Grange, with intermediate lozenges. In Sardinia, as I hope to show, there is evidence of the former existence of monuments of Mycenæan architecture in which the

chevron, the lozenge, and the spiral might have been seen associated as in Ireland. It is on this line, rather than on the Danube and the Elbe, that we find in a continuous zone that Cyclopean tradition of domed chambers which is equally illustrated at Mycenæ and at New Grange.

These are not more than indications, but they gain additional force from the converging evidence to which attention has already been called of an ancient line of intercourse, mainly, we may believe, connected with the tin trade between the East Mediterranean basin and the Iberian West. A further corroboration of the view that an Ægean impulse propagated itself as far as our own islands from that side is perhaps afforded by a very remarkable find in a British barrow.

I refer to the Bronze Age interment excavated by Canon Greenwell on Folkton Wold, in Yorkshire, in which, beside the body of a child, were found three carved chalk objects resembling round boxes with bossed lids. On one of these lids were grouped together, with a lozenge-shaped space between them, two partly spiraliform partly concentric circular ornaments, which exhibit before our eyes the degeneration of two pairs of returning spiral ornaments. Upon the sides of two of these chalk caskets, associated with chevrons, saltires, and lozenges, were rude indications of faces—eyes and nose of bird-like character—curiously recalling the early Ægean and Trojan types of Dr. Schliemann. These, as M. Reinach has pointed out, also find an almost exact parallel in the rude indications of the human face seen on the sculptured menhirs of the Marne and the Gard valleys. To this may be added the interesting comparisons supplied by certain clay vessels, of rounded form, somewhat resembling the chalk "caskets" discovered by MM. Siret in Spanish interments of the early metal age, in which eyes and eyebrows of a primitive style are inserted, as on the British relics, in the interspaces of linear ornamentation. The third chalk disc exhibits, in place of the human face, a butterfly with volute antennæ, reminding us of the appearance of butterflies as a decorative motive on the gold roundels from the shaft-graves of Mycenæ, as also on early Mycenæan gems of steatite from Crete; in the latter case with the feelers curving outwards in the same way. The stellate design with central circles on the lid of one of the chalk caskets is itself not impossibly a distant degeneration of the star-flowers on the same Mycenæan plates. Putting all these separate elements of resemblance together—the returning spiral and star, the rude face and butterfly—the suggestion of Ægean reminiscence becomes strong, but the other parallels lead us for the line of its transmission towards the Iberian rather than the Scandinavian route.[1]

So much, at least, results from these various comparisons that, whether we find the spiral motive in the extreme West or North of Europe, everything points to the Ægean world as its first European centre. But have we any right to regard it, even there, as of indigenous evolution?

It had been long my own conviction that the Ægean spiral system must itself be regarded as an offshoot of that of ancient Egypt, which as a decorative motive on scarabs goes back, as Prof. Petrie has shown, to the Fourth Dynasty. During the time of the Twelfth Dynasty, which, on general grounds, may be supposed roughly to correspond with the "Amorgan Period" of Ægean culture, it attained its apogee. The spiral convolutions now often cover the whole field of the scarab, and the motive begins to spread to a class of black bucchero vases, the chalk inlaying of whose ornaments suggests widespread European analogies. But the important feature to observe is that here, as in the case of the early Ægean examples, the original material on which the spiral ornament appears is stone, and that, so far from being derived from an advanced type of metal work, it goes back in Egypt to a time when metal was hardly known.

The prevalence of the spiral ornamentation on stone work in the Ægean islands and contemporary Egypt, was it merely to be regarded as a coincidence? To turn one's eye to the Nile Valley, was it simply another instance of the "*Mirage Orientale*"? For my own part, I ventured to believe that, as in the case of Northern Europe, the spread of this system was connected with many collateral symptoms of commercial interconnection, so here, too, the appearance of this early Ægean ornament would be found to lead to the demonstration of a direct intercourse between the Greek islands and Egypt at least a thousand years earlier than any that had hitherto been allowed.

One's thoughts naturally turned to Crete, the central island, with one face on the Libyan Sea—the natural source and seminary of Ægean culture—where fresh light was already being thrown on the Mycenæan civilisation by the researches of Prof. Halbherr, but the earlier prehistoric remains of which were still unexplored. Nor were these expectations unfounded. As the result of three expeditions—undertaken in three successive years, from the last of which I returned three months since—it has been my fortune to collect a series of evidences of a very early and intimate contact with Egypt, going back at least to the Twelfth Dynasty, and to the earlier half of the third millennium before our era. It is not only that in primitive deposits, like that of Hagios Onuphrios, scarabs, acknowledged by competent archæologists to be of Twelfth Dynasty date, occurred in association with steatite seals presenting the Ægean spiral ornamentation, and with early pottery answering to that of Amorgos and the second city of Troy. This by itself might be regarded by many as convincing. But—what from the point of view of intercourse and chronology is even more important—in the same deposit and elsewhere occurred early button-shaped and triangular seals of steatite with undoubted indigenous copies of Egyptian lotos designs characteristic of the same period, while in the case of the three-sided bead-seals it was possible to trace a regular evolution leading down to Mycenæan times. Nor was this all. Throughout the whole of the island there came to light a great variety of primitive stone vases, mostly of steatite, a large proportion of which reproduced the characteristic forms of Egyptian stone vases, in harder materials, going far back into the Ancient Empire. The returning spiral motive is also associated with these, as may be seen from a specimen now in the collection of Dr. Naue, of Munich.

A geological phenomenon which I was able to ascertain in the course of my recent exploration of the eastern part of the island goes far to explain the great importance which these steatite or "soapstone" fabrics played in the primitive culture of Crete and the Ægean islands. In the valley of the Sarakina stream I came upon vast deposits of this material, the diffusion of which could be further traced along a considerable tract of the southern coast. The abundant presence of this attractive and, at the same time, easily workable stone—then incomparably more valuable, owing to the imperfection of the potter's art—goes far to explain the extent to which these ancient Egyptian forms were imitated, and the consequent spread of the returning spiral motive throughout the Ægean.

In the matter of the spiral motive, Crete may thus be said to be the missing link between prehistoric Ireland and Scandinavia and the Egypt of the Ancient Empire. But the early remains of the island illustrate in many other ways the comparatively high level of culture already reached by the Ægean population in præ-Mycenæan times. Especially are they valuable in supplying the antecedent stages to many characteristic elements of the succeeding Mycenæan civilisation.

This ancestral relationship is nowhere more clearly traceable than in a class of relics which bear out the ancient claim of the islanders that they themselves had invented a system of writing to which the Phœnicians did not do more than add the finishing touches. Already, at the Oxford meeting of the Association, I was able to call attention to the evidence of the existence of a prehistoric Cretan script evolved by gradual simplification and selection from an earlier picture writing. This earlier stage is, roughly speaking, illustrated by a series of primitive seals belonging to the "Period of Amorgos." In the succeeding Mycenæan age the script is more conventionalised, often linear, and though developments of the earlier forms of seals are frequently found, they are usually of harder materials, and the system is applied to other objects. As the result of my most recent investigations, I am now able to announce the discovery of an inscribed prehistoric relic, which surpasses in interest and importance all hitherto known objects of this class. It consists of a fragment of what may be described as a steatite "Table of Offerings," bearing part of what appears to be a dedication of nine letters of probably syllabic values, answering to the same early Cretan script that is seen on the seals, and with two punctuations. It was obtained from the lowest level of a

[1] A further piece of evidence pointing in this direction is supplied by one of the chalk "caskets." On the upper disc of this, in the place corresponding with the double-spirals on the other example, appears a degeneration of the same motive in a more compressed form, resembling two sets of concentric horseshoes united at their bases. This recurs at New Grange, and single sets of concentric horseshoes, or semicircles, are found both there and at Gavrinnis. The degeneration of the returning spiral motive extends therefore to Brittany.

Mycenæan stratum, containing numerous votive objects, in the great cave of Mount Dikta, which, according to the Greek legend, was the birthplace of Zeus.

This early Cretan script, which precedes by centuries the most ancient records of Phœnician writing, and supplies, at any rate, very close analogies to what may be supposed to have been the pictorial prototypes of several of the Phœnician letters, stands in a direct relation to the syllabic characters used at a later date by the Greeks of Cyprus. The great step in the history of writing implied by the evolution of symbols of phonetic value from primitive pictographs is thus shown to have effected itself on European soil.

In many other ways the culture of Mycenæ—that extraordinary revelation from the soil of prehistoric Greece—can be shown to be rooted in this earlier Ægean stratum. The spiral system, still seen in much of its pure original form on the gold vessels and ornaments from the earlier shaft-graves of Mycenæ, is simply the translation into metal of the pre-existing steatite decoration. (See *Hellenic Journal*, xii., 1892, p. 221.)

The Mycenæan repoussé work in its most developed stage as applied to human and animal subjects has probably the same origin in stone work. Cretan examples, indeed, give the actual transition in which an intaglio in dark steatite is coated with a thin gold plate impressed into the design. On the other hand, the noblest of all creations of the Mycenæan goldsmith's art, the Vaphio cups, with their bold reliefs, illustrating the hunting and capture of wild bulls, find their nearest analogy in a fragment of a cup, procured by me from Knôsos, of Black Cretan steatite, with naturalistic reliefs, exhibiting a fig-tree in a sacred enclosure, an altar, and men in high action, which in all probability was originally coated, like the intaglio, with thin plates of gold.

In view of some still prevalent theories as to the origin of Mycenæan art, it is important to bear in mind these analogies and connections, which show how deeply set its roots are in Ægian soil. The Vaphio cups, especially, from their superior art, have been widely regarded as of exotic fabric. That the art of an European population in prehistoric times should have risen above that of contemporary Egypt and Babylonia was something beyond the comprehension of the traditional school. These most characteristic products of indigenous skill, with their spirited representations of a sport the traditional home of which in later times was the Thessalian plains, have been, therefore, brought from "Northern Syria"! Yet a whole series of Mycenæan gems exists executed in the same bold naturalistic style, and of local materials, such as lapis Lacedæmonius, the subjects of which are drawn from the same artistic cycle as those of the cups, and not one of these has as yet been found on the Eastern Mediterranean shores. Like the other kindred intaglios, they all come from the Peloponnese, from Crete, from the shores and islands of the Ægean, from the area, that is, where their materials were procured. Their lentoid and almond-shaped forms are altogether foreign to Semitic usage, which clung to the cylinder and cone. The finer products of the Mycenæan glyptic art on harder materials were, in fact, the outcome of long apprentice studies of the earlier Ægean population, of which we have now the record in the primitive Cretan seals, and the explanation in the vast beds of such an easily worked material as steatite.

But the importation of the most characteristic Mycenæan products from "Northern Syria" has become quite a moderate proposition beside that which we have now before us. In a recent communication to the French Academy of Inscriptions, Dr. Helbig has reintroduced to us as a more familiar figure. Driven from his prehistoric haunts on the Atlantic coasts, torn from the Cassiterides, dislodged even from his Thucididean plantations in pre-Hellenic Sicily, the Phœnician has returned, tricked out as the true "Mycenæan."

A great part of Dr. Helbig's argument has been answered by anticipation. Regardless of the existence of a regular succession of intermediate glyptic types, such as the "Melian" gems and the engraved seals of the geometrical deposits of the Greek mainland, like those of Olympia and of the Heræon at Argos, which link the Mycenæan with the classical series, Dr. Helbig takes a verse of Homer to hang from it a theory that seals and engraved stones were unknown to the early Greeks. On this imaginary fact he builds the astounding statement that the engraved gems and seals found with Mycenæan remains must be of foreign and, as he believes, Phœnician importation. The stray diffusion of one or two examples of Mycenæan pots to the coast of Palestine, the partial resemblance of some Hittite bronze figures, executed in a more barbarous Syrian style, to specimens of quite different fabric found at Tiryns, Mycenæ, and, it may be added, in a Cretan cave near Sybrita, the wholly unwarranted attribution to Phœnicia of a bronze vase-handle found in Cyprus, exhibiting the typical lion-headed demons of the Mycenæans—these are only a few salient examples of the reasoning by which the whole prehistoric civilisation of the Greek world, so instinct with naturalism and individuality, is handed over to the least original member of the Semitic race. The absence in historic Greece of such arts as that of *intarsia* in metal work, of glass-making (if true) and of porcelain-making, is used as a conclusive argument against their practice by an Ægean population, of uncertain stock, a thousand years earlier, as if in the intervening dark ages between the primitive civilisation of the Greek lands and the Classical Renaissance no arts could have been lost!

Finally, the merchants of Keftô depicted on the Egyptian monuments are once more claimed as Phœnicians, and with them—though this is by no means a necessary conclusion, even from the premise—the precious gifts they bear, including vases of characteristic Mycenæan form and ornament. All this is diametrically opposed to the conclusions of the most careful inquirer into the origins of this mysterious people, Dr. W. Max Muller (to be distinguished from the eminent Professor); who shows that the list of countries in which Keftô occurs places them beyond the limit of Phœnicia or of any Semitic country, and connects them rather with Cilicia and with Cyprus, the scene, as we now know, of important Mycenæan plantations. It is certain that not only do the Keftiu traders bear articles of Mycenæan fabric, but their costume, which is wholly un-Semitic, their leggings and sandals, and the long double locks of hair streaming down below their armpits, identify them with the men of the frescoes of Mycenæ, and of the Vaphio and Knôsian cups.

The truth is that these Syrian and Phœnician theories are largely to be traced to the inability to understand the extent to which the primitive inhabitants of the Ægean shores had been able to assimilate exotic arts without losing their own individuality. The prococious offspring of our continent, first come to man's estate in the Ægean island world, had acquired cosmopolitan tastes, and already stretched forth his hands to pluck the fruit of knowledge from Oriental boughs. He had adopted foreign fashions of dress and ornament. His artists revelled in lion hunts and palm-trees. His very worship was infected by the creations of foreign religions.

The great extent to which the Mycenæans had assimilated exotic arts and ideas can only be understood when it is realised that this adaptive process had begun at least a thousand years before, in the earlier period of Ægean culture. New impulses from Egypt and Chaldæa now succeed the old. The connection with Eighteenth and Nineteenth Dynasty Egypt was of so intimate a kind that it can only be explained by actual settlement from the Ægean side. The abundant relics of Ægean ceramic manufactures found by Prof. Petrie on Egyptian sites fully bear out this presumption. The early marks on potsherds discovered by that explorer seem to carry the connection back to the earlier Ægean period, but the painted pottery belongs to what may broadly be described as Mycenæan times. The earliest relics of this kind found in the rubbish heaps of Kahun, though it can hardly be admitted that they go quite so far back as the Twelfth Dynasty date assigned to them by Mr. Petrie (*c.* 2500 B.C.), yet correspond with the earliest Mycenæan classes found at Thera and Tiryns, and seem to find their nearest parallels in pottery of the same character from the cave of Kamares on the northern steep of the Cretan Ida, recently described by Mr. J. L. Myres and by Dr. Lucio Mariani. Vases of the more typical Mycenæan class have been found by Mr. Petrie in a series of deposits dated, from the associated Egyptian relics, from the reign of Thothmes III. onwards (1450 B.C.). There is nothing Phœnician about these—with their seaweeds and marine creatures they are the true products of the island world of Greece. The counterpart to these Mycenæan imports in Egypt is seen in the purely Egyptian designs which now invade the northern shores of the Ægean, such as the ceiling of the sepulchral chamber at Orchomenos, or the wall-paintings of the palace at Tiryns—almost exact copies of the ceilings of the Theban tombs—designs distinguished by the later Egyptian combination of the spiral and plant ornament which at this period supersedes the pure returning spiral of the earlier dynasties. The same contemporary

evidence of date is seen in the scarabs and porcelain fragments with the cartouches of Queen Tyi and Amenhotep III., found in the Mycenæan deposits. But more than a mere commercial connection between the Ægean seat of Mycenæan culture and Egypt seems to be indicated by some of the inlaid daggers from the Acropolis tombs. The subject of that representing the ichneumons hunting ducks amidst the lotos thickets beside a stream that can only be the Nile, as much as the intarsia technique, is so purely of Egypt that it can only have been executed by a Mycenæan artificer resident within its borders. The whole cycle of Egyptian Nile-pieces thoroughly penetrated Mycenæan art—the duck-catcher in his Nile-boat, the waterfowl and butterflies among the river-plants, the spotted cows and calves, supplied fertile motives for the Mycenæan goldsmiths and ceramic artists. The griffins of Mycenæ reproduce an elegant creation of the New Empire, in which an influence from the Asiatic side is also traceable.

The assimilation of Babylonian elements was equally extensive. It, too, as we have seen, had begun in the earlier Ægean period, and the religious influence from the Semitic side, of which traces are already seen in the assimilation of the more primitive "idols" to Eastern models, now forms a singular blend with the Egyptian, as regards, at least, the externals of cult. We see priests, in long folding robes of Asiatic cut, leading griffins, offering doves, holding axes of a type of Egyptian derivation which seems to have been common to the Syrian coast, the Hittite regions of Anatolia, and Mycenæan Greece. Female votaries in flounced Babylonian dresses stand before seated Goddesses, rays suggesting those of Shamas shoot from a Sun-God's shoulders, conjoined figures of moon and star recall the symbols of Sin and Istar, and the worship of a divine pair of male and female divinities is widely traceable, reproducing the relations of a Semitic Bel and Beltis. The cylinder subjects of Chaldæan art continually assert themselves: a Mycenæan hero steps into the place of Gilgames or Eabani, and renews their struggles with wild beasts and demons in the same conventional attitudes, of which Christian art has preserved a reminiscence in its early type of Daniel in the lions' den. The peculiar schemes resulting from, or, at least, brought into continual prominence by the special conditions of cylinder engraving, with the constant tendency to which it is liable of the two ends of the design to overlap, deeply influenced the glyptic style of Mycenæ. Here, too, we see the same animals with crossed bodies, with two bodies and a single head, or simply confronted. These latter affiliations to Babylonian prototypes have a very important bearing on many later offshoots of European culture. The tradition of these heraldic groups preserved by the later Mycenæan art, and communicated by it to the so-called "Oriental" style of Greece, finds in another direction its unbroken continuity in ornamental products of the Hallstatt province, and that of the late Celtic metal workers.

"But this," exclaims a friendly critic, "is the old heresy—the '*Mirage Orientale*' over again. Such heraldic combinations have originated independently elsewhere:—why may they not be of indigenous origin in primitive Europe?"

They certainly may be. Confronted figures occur already in the Dordogne caves. But, in a variety of instances, the historic and geographical connection of these types with the Mycenæan, and those in turn with the Oriental, is clearly made out. That system which leaves the least call on human efforts at inventiveness seems in anthropology to be the safest.

Let us then fully acknowledge the indebtedness of early Ægean culture to the older civilisations of the East. But this indebtedness must not be allowed to obscure the fact that what was borrowed was also assimilated. On the easternmost coast of the Mediterranean, as in Egypt, it is not in a pauper's guise that the Mycenæan element makes its appearance. It is rather the invasion of a conquering and superior culture. It has already outstripped its instructors. In Cyprus, which had lagged behind the Ægean peoples in the race of progress, the Mycenæan relics make their appearance as imported objects of far superior fabric, side by side with the rude insular products. The final engrafting on Cypriote soil of what may be called a colonial plantation of Mycenæ later reacts on Assyrian art, and justifies the bold theory of Prof. Brunn that the sculptures of Nineveh betray Greek handiwork. The concordant Hebrew tradition that the Philistines were immigrants from the Islands of the Sea, the name "Cherethim," or Cretans, actually applied to them, and the religious ties which attached "Minoan" Gaza to the cult of the Cretan Zeus, are so many indications that the Ægean settlements, which in all probability existed in the Delta, extended to the neighbouring coast of Canaan, and that amongst other towns the great staple of the Red Sea trade had passed into the hands of these prehistoric Vikings. The influence of the Mycenæans on the later Phœnicians is abundantly illustrated in their eclectic art. The Cretan evidence tends to show that even the origins of their alphabet receive illustration from the earlier Ægean pictography. It is not the Mycenæans who are Phœnicians. It is the Phœnicians who, in many respects, acted as the depositaries of decadent Mycenæan art.

If there is one thing more characteristic than another of Phœnician art, it is its borrowed nature, and its incongruous collocation of foreign elements. Dr. Helbig himself admits that if Mycenæan art is to be regarded as the older Phœnician, the Phœnician historically known to us must have changed his nature. What the Mycenæans took they made their own. They borrowed from the designs of Babylonian cylinders, but they adapted them to gems and seals of their own fashion, and rejected the cylinders themselves. The influence of Oriental religious types is traceable on their signet rings, but the liveliness of treatment and the dramatic action introduced into the groups separate them, *toto cœlo*, from the conventional schematism of Babylonian cult-scenes. The older element, the sacred trees and pillars which appear as the background of these scenes—on this I hope to say more later on in this Section—there is no reason to regard here as Semitic. It belongs to a religious stage widely represented on primitive European soil, and nowhere more persistent than in the West.

Mycenæan culture was permeated by Oriental elements, but never subdued by them. This independent quality would alone be sufficient to fix its original birthplace in an area removed from immediate contiguity with that of the older civilisations of Egypt and Babylonia. The Ægean island world answers admirably to the conditions of the case. It is near, yet sufficiently removed, combining maritime access with insular security. We see the difference if we compare the civilisation of the Hittites of Anatolia and Northern Syria, in some respects so closely parallel with that of Mycenæ. The native elements were there cramped and trammelled from the beginning by the Oriental contact. No real life and freedom of expression was ever reached; the art is stiff, conventional, becoming more and more Asiatic, till finally crushed out by Assyrian conquest. It is the same with the Phœnicians. But in prehistoric Greece the indigenous element was able to hold its own, and to recast what it took from others in an original mould. Throughout its handiwork there breathes the European spirit of individuality and freedom. Prof. Petrie's discoveries at Tell-el-Amarna show the contact of this Ægean element for a moment infusing naturalism and life into the time-honoured conventionalities of Egypt itself.

A variety of evidence, moreover, tends to show that during the Mycenæan period the earlier Ægean stock was reinforced by new race elements coming from north and west. The appearance of the primitive fiddle-bow-shaped *fibula* or safety-pin brings Mycenæan Greece into a suggestive relation with the Danube Valley and the Terremare of Northern Italy. Certain ceramic forms show the same affinities; and it may be noted that the peculiar "two-storied" structure of the "Villanova" type of urn which characterises the earliest Iron Age deposits of Italy finds already a close counterpart in a vessel from an Akropolis grave at Mycenæ—a parallelism which may point to a common Illyrian source. The painted pottery of the Mycenæans itself, with its polychrome designs, betrays Northern and Western affinities of a very early character, though the glaze and exquisite technique were doubtless elaborated in the Ægean shores. Examples of spiraliform painted designs on pottery going back to the borders of the Neolithic period have been found in Hungary and Bosnia. In the early rock-tombs of Sicily of the period anterior to that marked by imported products of the fully developed Mycenæan culture are found unglazed painted wares of considerable brilliancy, and allied classes recur in the heel of Italy and in the cave deposits of Liguria of the period transitional between the use of stone and metal. The "household gods," if so we may call them, of the Mycenæans also break away from the tradition of the marble Ægean forms. We recognise the coming to the fore again of primitive European clay types in a more advanced technique. Here, too, the range of comparison takes us to the same Northern and Western area. Here, too, in Sicily and Liguria, we see the primitive art of ceramic painting already applied to these at the close of the Stone Age. A rude female clay figure found in the Arene Candide cave near Finalmarina, the upper part of the body of which, armless and rounded, is

painted with brown stripes on a pale rose ground, seems to me to stand in a closer relation to the prototype of a well-known Mycenæan class than any known example. A small painted image, with punctuated cross-bands over the breast, from a sepulchral grotto at Villafrati, near Palermo, belongs to the same early family as the *bucchero* types of Butmir, in Bosnia. Unquestionable parallels to the Mycenæan class have been found in early graves in Servia, of which an example copied by me some years since in the museum at Belgrade was found near the site of that later emporium of the Balkan trade, Viminacium, together with a cup attesting the survival of the primitive Ægean spirals. These extensive Italian and Illyrian comparisons, which find, perhaps, their converging point in the North-Western corner of the Balkan peninsula, show, at least approximately, the direction from which this new European impulse reached the Ægean shores.

It is an alluring supposition that this North-Western infusion may connect itself with the spread of the Greek race in the Ægean islands and the Southern part of the Balkan peninsula. There seems, at least, to be a reasonable presumption in favour of this view. The Mycenæan tradition, which underlies so much of the classical Greek art, is alone sufficient to show that a Greek element was at least included in the Mycenæan area of culture. Recent criticism has found in the Mycenæan remains the best parallel to much of the early arts and industries recorded by the Homeric poems. The *megaron* of the palaces at Tiryns and Mycenæ is the hall of Odysseus; the inlaid metal work of the shield of Achilles recalls the Egypto-Mycenæan intarsia of the dagger blades; the cup of Nestor with the feeding doves, the subjects of the ornamental design—the siege-piece, the lion-hunt, the hound with its quivering quarry—all find their parallels in the works of the Mycenæan goldsmiths. The brilliant researches of Dr. Reichel may be said to have resulted in the definite identification of the Homeric body-shield with the most typical Mycenæan form, and have found in the same source the true explanation of the greaves and other arms and accoutrements of the epic heroes.

That a Greek population shared in the civilisation of Mycenæ cannot reasonably be denied, but that is far from saying that this was necessarily the only element, or even the dominant element. Archæological comparisons, the evidence of geographical names and consistent tradition, tend to show that a kindred race, represented later by the Phrygians on the Anatolian side, the race of Pelops and Tantalos, the special votaries of Kybelê, played a leading part. In Crete a non-Hellenic element, the Eteocretes, or "true Cretans," the race of Minôs, whose name is bound up with the earliest sea-empire of the Ægean, and perhaps identical with that of the Minyans of continental Greece, preserved their own language and nationality to the borders of the classical period. The Labyrinth itself, the double-headed axe as a symbol of the divinity called Zeus by the Greek settlers, the common forms in the characters of the indigenous script, local names and historical traditions, further connect these Mycenæan aborigines of Crete with the primitive population, it, too, of European extraction, in Caria and Pisidia, and with the older elements in Lycia.

It is difficult to exaggerate the part played in this widely ramifying Mycenæan culture on later European arts from prehistoric times onwards. Beyond the limits of its original seats, primitive Greece and its islands, and the colonial plantations thrown out by it to the west coast of Asia Minor to Cyprus, and in all probability to Egypt and the Syrian coast, we can trace the direct diffusion of Mycenæan products, notably the ceramic wares, across the Danube to Transylvania and Moldavia. In the early cemeteries of the Caucasus the fibulas and other objects indicate a late Mycenæan source, though they are here blended with allied elements of a more Danubian character. The Mycenæan impress is very strong in Southern Italy, and, to take a single instance, the prevailing sword-type of that region is of Mycenæan origin. Along the western Adriatic coast the same influence is traceable to a very late date in the sepulchral stelæ of Pesaro and the tympanum relief of Bologna, and bronze knives of the prehistoric Greek type find their way into the later Terremare. At Orvieto and elsewhere have even been discovered Mycenæan lentoid gems. In Sicily the remarkable excavations of Prof. Orsi have brought to light a whole series of Mycenæan relics in the beehive rock-tombs of the south-eastern coast, associated with the later class of Sikel fabrics.

Sardinia, whose name has with great probability been connected with the Shardanas, who, with the Libyan and Ægean races, appear as the early invaders of Egypt, has already produced a Mycenæan gold ornament. An unregarded fact points further to the probability that it formed an important outpost of Mycenæan culture. In 1853 General Lamarmora first printed a MS. account of Sardinian antiquities, written in the later years of the fifteenth century by a certain Gilj, and accompanied by drawings made in 1497 by Johan Virde, of Sassari. Amongst these latter (which include, it must be said, some gross falsifications) is a capital and part of a shaft of a Mycenæan column in a style approaching that of the façade of the "Treasury of Atreus." It seems to have been found at a place near the Sardinian Olbia, and Virde has attached to it the almost prophetic description "*columna Pelasgica*." That it is not a fabrication due to some traveller from Greece is shown by a curious detail. Between the chevrons that adorn it are seen rows of eight-rayed stars, a detail unknown to the Mycenæan architectural decoration till it occurred on the painted base of the hearth in the *megaron* of the palace at Mycenæ excavated by the Greek Archæological Society in 1886. In this neglected record, then, we have an indication of the former existence in Sardinia of Mycenæan monuments, perhaps of palaces and royal tombs comparable to those of Mycenæ itself.

More isolated Mycenæan relics have been found still further afield, in Spain, and even the Auvergne, where Dr. Montelius has recognised an evidence of an old trade connection between the Rhone valley and the Eastern Mediterranean, in the occurrence of two bronze double axes of Ægean form. It is impossible to do more than indicate the influence exercised by the Mycenæan arts on those of the early Iron Age. Here it may be enough to cite the late Mycenæan parallels afforded by the Ægina Treasure to the open-work groups of bird-holding figures and the pendant ornaments of a whole series of characteristic ornaments of the Italo-Hallstatt culture.

In this connection, what may be called a sub-Mycenæan survival in the North-Western corner of the Balkan peninsula has a special interest for the Celtic West. Among the relics obtained by the fruitful excavations conducted by the Austrian archæologists in Bosnia and Herzegovina, and notably in the great prehistoric cemetery of Glasinatz, a whole series of Early Iron Age types betray distinct Mycenæan affinities. The spiral motive and its degeneration—the concentric circles grouped together with or without tangential lines of connection—appears on bronze torques, on fibulæ of Mycenæan descent, and the typical finger-rings with the besil at right angles to the ring. On the plates of other "spectacle fibulæ" are seen triquetral scrolls singularly recalling the gold plates of the Akropolis graves of Mycenæ. These, as well as other parallel survivals of the spiral system in the Late Bronze Age of the neighbouring Hungarian region, I have elsewhere[1] ventured to claim as the true source from which the Alpine Celts, together with many Italo-Illyric elements from the old Venetian province at the head of the Adriatic, drew the most salient features of their later style, known on the continent as that of La Tène. These Mycenæan survivals and Illyrian forms engrafted on the "Hallstatt" stock were ultimately spread by the conquering Belgic tribes to our own islands, to remain the root element of the Late Celtic style in Britain—where the older spiral system had long since died a natural death—and in Ireland to live on to supply the earliest decorative motives of its Christian art.

From a Twelfth Dynasty scarab to the book of Durrow or the font of Deerhurst is a far cry. But, as it was said of old, "Many things may happen in a long time." We have not to deal with direct transmission *per saltum*, but with gradual propagation through intervening media. This brief survey of "the Eastern Question in Anthropology" will not have been made in vain, if it helps to call attention to the mighty part played by the early Ægean culture as the mediator between primitive Europe and the older civilisations of Egypt and Babylonia. Adequate recognition of the Eastern background of the European origins is not the "Oriental Mirage." The independent European element is not affected by its power of assimilation. In the great days of Mycenæ we see it already as the equal, in many ways the superior, of its teachers, victoriously reacting on the older countries from which it had acquired so much. I may perhaps be pardoned if in these remarks, availing myself of personal investigations, I have laid some stress on the part which Crete has played in this first emancipation of the European genius. There far earlier than elsewhere we can trace

[1] Rhind Lectures, 1895, "On the Origins of Celtic Art," summaries of which appeared in the *Scotsman*.

the vestiges of primæval intercourse with the valley of the Nile. There more clearly than in any other area we can watch the continuous development of the germs which gave birth to the higher Ægean culture. There before the days of Phœnician contact a system of writing had already been worked out which the Semite only carried one step further. To Crete the earliest Greek tradition looks back as the home of divinely inspired legislation and the first centre of maritime dominion.

Inhabited since the days on the first Greek settlements by the same race, speaking the same language, and moved by the same independent impulses, Crete stands forth again to day as the champion of the European spirit against the yoke of Asia.

SECTION K.

BOTANY.

Opening Address by D. H. Scott, F.R.S., Honorary Keeper of the Jodrell Laboratory, Royal Gardens, Kew, President of the Section.

Present Position of Morphological Botany.

The object of modern morphological botany (the branch of our science to which I propose to limit my remarks) is the accurate comparison of plants, both living and extinct, with the object of tracing their real relationships with one another, and thus of ultimately constructing a genealogical tree of the vegetable kingdom. The problem is thus a purely historical one, and is perfectly distinct from any of the questions with which physiology has to do.

Yet there is a close relation between these two branches of biology; at any rate, to those who maintain the Darwinian position. For from that point of view we see that all the characters which the morphologist has to compare are, or have been, adaptive. Hence it is impossible for the morphologist to ignore the functions of those organs of which he is studying the homologies. To those who accept the origin of species by variation and natural selection there are no such things as morphological characters pure and simple. There are not two distinct categories of characters—a morphological and a physiological category—for all characters alike are physiological. "According to that theory, every organ, every part, colour, and peculiarity of an organism must either be of benefit to an organism itself, or have been so to its ancestors. . . . Necessarily, according to the theory of natural selection, structures either are present because they are selected as useful, or because they are still inherited from ancestors to whom they were useful, though no longer useful to the existing representatives of those ancestors." (Lankester, "Advancement of Science," p. 307.)

The useful characters may have become fixed in comparatively recent times, or a long way back in the past. In the latter case the character in question may have become the property of a large group, and thus, as we say, may have become morphologically important.

For instance, parasitic characters, such as the suppression of chlorophyll, are equally adaptive in Dodder and in the Fungi. In Dodder, however, such characters are of recent origin and of little morphological importance, not hindering us from placing the genus in the natural order Convolvulaceæ; while in Fungi equally adaptive characters have become the common property of a great class of plants.

Then, again, the existence of a definite sporophyte generation, which is the great character of all the higher plants, is in certain Fungi inconstant, even among members of the same species.

Although there is no essential difference between adaptive and morphological characters, there is a great difference in the morphologist's and the physiologist's way of looking at them. The physiologist is interested in the question how organs work; the morphologist asks, what is their history?

The morphologist may well feel discouraged at the vastness of the work before him. The origin of the great groups of plants is perhaps, after all, an insoluble problem, for the question is not accessible either to observation or experiment.

All that we can directly observe or experiment upon is the occurrence of variations—perhaps the most important line of research in biology, for it was the study of variation that led Darwin and Wallace to their grand generalisation. Many observers are working to-day in the spirit of the great masters, and it is certain that their work will be fruitful in results. It is evident, however, that such investigations can at most only throw a side light on the historical question of the origin of the existing orders and classes of living things. The morphologist has to attack such questions by other methods of research.

The embryological method has so far scarcely received justice from botanists. A great deal of what is called embryology in botany is not embryology at all, but relates to pre-fertilisation changes. Of real embryology—that is to say, the development of the young plant from the fertilised ovum—there is much less than we might expect. Thus no comparative investigation of the embryology of either Dicotyledons or Monocotyledons has ever been carried out, our knowledge being entirely based on a few isolated examples.

In the cases which have been investigated perhaps excessive attention has been devoted to the first divisions of the ovum, the importance of which, as Sachs long ago showed, has been overrated, while the later stages, when the differentiation of organs and tissues is actually in progress, have been comparatively neglected.

The law of recapitulation (or repetition of phylogeny in ontogeny) has been very inadequately tested in the vegetable kingdom. Whatever its value may be, it is certainly desirable that the development of plants as well as animals should be considered from this point of view; and this has so far been done in but very few cases. M. Massart, of Brussels, has made some investigations with this object on the development of seedlings and of individual leaves. He is led to the conclusion that examples of recapitulation are rare among plants. ("La Récapitulation et l'Innovation en Embryologie Végétale," *Bull. de la Soc. roy. de Bot. de Belgique*, vol. xxxiii., 1894.)

So far, at least, embryological research has only yielded certain proof of recapitulation in a few cases, as in the well-known example of the phyllode-bearing acacias, in which the first leaves of the seedling are normal, while the later formed ones gradually assume the reduced phyllode form.

A less familiar example is afforded by *Gunnera*. Here, as is well known, the mature stem has a structure totally different from that of ordinary Dicotyledons, and much resembling that characteristic of most Ferns. In most species of *Gunnera* there are a number of distinct vascular cylinders in the stem, instead of one only, and there is never the slightest trace, so far as the adult plant is concerned, of the growth by means of cambium, which is otherwise so general in the class. The seedling stem, however, is not only monostelic below the cotyledons, but in this region, though nowhere else, shows distinct secondary growth. Thus, if we were in any doubt as to the general affinities of *Gunnera*, owing to its extraordinary mature structure, we should at once be put on the right track by the study of the embryonic stem, which alone retains the characteristic dicotyledonous mode of growth.

It is only in a few cases, however, and for narrow ranges of affinity, that the doctrine of recapitulation has at present helped in the determination of relationships among plants. Beyond this, conclusions based on embryology alone tend to become merely conjectural and subjective. In fact, all comparative work, in so far as it is limited to plants now living, suffers under the same weakness that it can never yield certain results, for the question whether given characters are relatively primitive or recently acquired is one upon which each naturalist is left to form his own opinion, as the origin of the characters cannot be observed.

To determine the blood-relationships of organisms it is necessary to decipher their past history, and the best evidence we can have (when we can get it) is from the ancient organisms themselves. The problem of the morphologist is an historical one, and contemporary documentary evidence is necessarily the best. It is palæontology alone which can give us the real historical facts.

Anatomical Characters.

In judging of the affinities of fossil plants we are often compelled to make great use of vegetative characters, and more particularly of characters drawn from anatomical structure. It is true that in many cases we do so because we cannot help ourselves, such anatomical features being the only characters available in many of the specimens as at present known. But the value of the method has been amply proved in other cases where the reproductive structures have also been discovered, and are found to fully confirm the conclusions based on anatomy. I need only mention the great groups of the Lepidodendreæ and the Calamites, in each of which the anatomical characters, when accurately known, put us at once on the right track, and lead to

results which are only confirmed by the study of the reproductive organs.

In this matter fossil botany is likely to react in a beneficial way on the study of recent plants, calling attention to points of structure which have been passed over, and showing us the value of characters of a kind to which systematists had until recently paid but little attention. At present, owing to the work of Radlkofer, Vesque, and others, anatomical characters are gradually coming into use in the classification of the higher plants, and in some quarters there may even be a tendency to over-estimate their importance. Such exaggeration, however, is only a temporary fault incident to the introduction of a comparatively new method. In the long run nothing but good can result from the effort to place our classification on a broader basis. In most cases the employment of additional characters will doubtless serve only to further confirm the affinities already detected by the acumen of the older taxonomists. There are plenty of doubtful points, however, where new light is much needed; and even where the classification is not affected it will be a great scientific gain to know that its divisions are based on a comparison of the whole structure, and not merely on that of particular organs.

The fact that anatomical characters are adaptive is undeniable, but this applies to all characters, such difference as there is being merely one of degree. Cases are not wanting where the vegetative tissues show greater constancy than the organs of reproduction, as, for example, in the Marattiaceæ, where there is a great uniformity in anatomical structure throughout the family, while the sporangia show the important differences on which the distinction of the genera is based. It is in fact a mistake to suppose that anatomical characters are necessarily the expression of recent adaptations. On the contrary, it is easy to cite examples of marked anatomical peculiarities which have become the common property of large groups of plants.

For instance, to take a case in which I happen to have been specially interested, the presence of bast to the inside as well as to the outside of the woody zone is a modification of dicotyledonous structure which is in many groups, at least of ordinal value. The peculiarity is constant throughout the orders Onagraceæ, Lythraceæ, Myrtaceæ, Solanaceæ, Asclepiadaceæ, and Apocynaceæ, not to mention some less important groups. In other families, such as the Cucurbitaceæ and the Gentianeæ, it is nearly constant throughout the order, but subject to some exceptions. Among the Compositæ a similar, if not identical, peculiarity appears in some of the sub-order Cichoriaceæ, but is here not of more than generic value. In *Campanula* the systematic importance of internal phloëm is even less, for it appears in some species and not in others. Lastly, there are cases in which a similar character actually appears as an individual variation, as in *Carum Carvi*, and, under abnormal conditions, in *Phaseolus multiflorus*.

These latter cases seem to me worthy of special study, for in them we can trace, under our very eyes, the first rise of anatomical characters which have elsewhere become of high taxonomic importance. A comparative study of the anatomy of any group of British plants, taking the same species growing under different conditions, would be sure to yield interesting results if any one had the patience to undertake it.

Enough has been said to show that a given anatomical character may be of a high degree of constancy in one group while extremely variable in another, a fact which is already perfectly familiar as regards the ordinary morphological characters. For example, nothing is more important in phanerogamic classification than the arrangement of the floral organs as shown in ground-plan or floral diagram. Yet Prof. Trail's observations, which he has been good enough to communicate to me, show that in one and the same species, or even individual, of *Polygonum*, almost every conceivable variation of the floral diagram may be found.

There is, in fact, no "royal road" to the estimation of the relative importance of characters; the same character which is of the greatest value in one group may be trivial in another; and this holds good equally whether the character be drawn from the external morphology or from the internal structure.

Our knowledge of the comparative anatomy of plants, from this point of view, is still very backward, and it is quite possible that the introduction of such characters into the ordinary work of the Herbarium may be premature; certainly it must be conducted with the greatest judgment and caution. We have not yet got our data, but every encouragement should be given to the collection of such data, so that our classification in the future may rest on the broad foundation of a comparison of the entire structure of plants.

In estimating the relative importance of characters of different kinds we must not forget that characters are often most constant when most adaptive. Thus, as Prof. Trail informs me, the immense variability of the flowers of *Polygonum* goes together with their simple method of self-fertilisation. The exact arrangement is of little importance to the plant, and so variation goes on unchecked. In flowers with accurate adaptation to fertilisation by insects such variability is not found, for any change which would disturb the perfection of the mechanism is at once eliminated by natural selection.

Histology.

I propose to say but little on questions of minute histology, a subject which lies on the borderland between morphology and physiology, and which will be dealt with next Tuesday far more competently than I could hope to treat it. Last year my predecessor in the presidency of this Section spoke of a histological discovery (that of the nucleus, by Robert Brown) as "the most epoch-making of events" in the modern history of botany. The histological questions before us at the present day may be of no less importance, but we cannot as yet see them in proper perspective. The centrosomes, those mysterious protoplasmic particles which have been supposed to preside over the division of the nucleus, and thus to determine the plane of segmentation, if really permanent organs of the cell, would have to rank as co-equal with the nucleus itself. If, on the other hand, as some think, they are not constant morphological entities, but at most temporary structures differentiated *ad hoc*, then we are brought face to face with the question whether the causes of nuclear division lie in the nucleus itself or in the surrounding protoplasm.

Nothing can be more fascinating than such problems, and nothing more difficult. We have, at any rate, reason to congratulate ourselves that English botanists are no longer neglecting the study of the nucleus and its relation to the cell. For a long time little was done in these subjects in our country, or at least little was published, and botanists were generally content to take their information from abroad, not going beyond a mere verification of other men's results. Now we have changed all that, as the communications to this Section sufficiently testify.

Nothing is more remarkable in histology than the detailed agreement in the structure and behaviour of the nucleus in the higher plants and the higher animals, an agreement which is conspicuously manifest in those special divisions which take place during the maturation of the sexual cells. Is this striking agreement the product of inheritance from common ancestors, or is the parallelism dependent solely on similar physical conditions in the cells? This is one of the great questions upon which we may hope for new light from the histological discussion next week.

Alternation of Generations.

We have known ever since the great discoveries of Hofmeister that the development of a large part of the vegetable kingdom involves a regular alternation of two distinct generations, the one, which is sexual, being constantly succeeded—so far as the normal cycle is concerned—by the other which is asexual. This alternation is most marked in the mosses and ferns, taking these words in their widest sense, as used by Prof. Campbell in his recent excellent book. In the Bryophyta, the ordinary moss or liverwort plant is the sexual generation, producing the ovum, which, when fertilised, gives rise to the moss-fruit, which here alone represents the asexual stage. The latter forms spores from which the sexual plant is again developed.

In the Pteridophyta the alternation is equally regular, but the relative development of the two generations is totally different, the sexual form being the insignificant prothallus, while the whole fern-plant, as we ordinarily know it, is the asexual generation.

The thallus of some of the lower Bryophyta is quite comparable with the prothallus of a fern, so as regards the sexual generation there is no difficulty in seeing the relation of the two classes; but when we come to the asexual generation or sporophyte the case is totally different. There is no appreciable resemblance between the fruit of any of the Bryophyta and the plant of any vascular Cryptogam.

There is thus a great gap within the Archegoniatæ; there is

another at the base of the series, for the regular alternation of the Bryophyta is missing in the Algæ and Fungi, and the question as to what corresponds among these lower groups to the sporophyte and oöphyte of the higher Cryptogams is still disputed.

Now as regards this life-cycle, which is characteristic of all plants higher than Algæ and Fungi, there are two great questions at present open. The one is general: are the two generations, the sporophyte and the oöphyte, homologous with one another, or is the sporophyte a new formation intercalated in the life-history, and not comparable to the sexual plant? The former kind of alternation has been called homologous, the latter antithetic. This question involves the *origin* of alternation; its solution would help us to bridge over the gap between the Archegoniatæ and the lower plants. The second problem is more special: has the sporophyte of the Pteridophyta, which always appears as a complete plant, been derived from the simple and totally different sporophyte of the Bryophyta, or are the two of distinct origin?

At present it is usual, at any rate in England, to assume the antithetic theory of alternation. Prof. Bower, its chief exponent, says ("Spore-producing Members," *Phil. Trans.*, vol. clxxxv. B. (1894), p. 473): "It will also be assumed that, whatever may have been the circumstances which led to it, antithetic alternation was brought about by elaboration of the zygote [*i.e.* the fertilised ovum] so as to form a new generation (the sporophyte) interpolated between successive gametophytes, and that the neutral generation is not in any sense the result of modification or metamorphosis of the sexual, but a new product having a distinct phylogenetic history of its own." In his essay on "Antithetic as distinguished from Homologous Alternation of Generations in Plants" ("Annals of Botany," vol. iv. (1890) p. 362), the author describes the hypothetical first appearance of the sporophyte as follows: "Once fertilised, a zygote might in these plants [the first land plants] divide up into a number of portions (carpospores), each of which would then serve as a starting-point of a new individual."

On this view, the sporophyte first appeared as a mere group of spores formed by the division of the fertilised ovum. Consequently the inference is drawn that all the vegetative parts of the sporophyte have arisen by the "sterilisation of potentially sporogenous tissue." That is to say, there was nothing but a mass of spores to start with, so whatever other tissues and organs the sporophyte may form must be derived from the conversion of spore-forming cells into vegetative cells. Prof. Bower has worked out this view most thoroughly, and as the result he is not only giving us the most complete account of the development of sporangia which we have ever had, but he has also done much to clear up our ideas, and to show us what the course of evolution ought to have been if the assumptions required by the antithetic theory were justified.

Without entering into any detailed criticism of this important contribution to morphology, which is still in progress, I wish to point out that we are not, after all, bound to accept the assumption on which the theory rests. There is another view in the field, for which, in my opinion, much is to be said. The antithetic theory is receiving a most severe test at the friendly hands of its chief advocate. Should it break down under the strain we need not despair, for another hypothesis remains which I think quite equally worthy of verification.

This is the theory of Pringsheim, according to which the two generations are *homologous* one with another, the oöphyte corresponding to a sexual individual among Thallophytes, the sporophyte to an asexual individual. To quote Pringsheim's own words ("Gesammelte Abhandlungen," II. p. 370): "The alternation of generations in mosses is immediately related to those phenomena of the succession of free generations in Thallophytes, of which the one represents the neutral, the other the sexual plant." Further on (*ibid.*, p. 371) he illustrates this by saying: "The moss sporogonium stands in about the same relation to the moss plant as the sporangium-bearing specimens of *Saprolegnia* stand to those which bear oögonia, or as, among the Florideæ, the specimens with tetraspores are related to those with cystocarps." This gets rid of the intercalation of a new generation altogether; we only require the modification of the already existing sexual and asexual forms of the Thallophytes.

The sudden appearance of something completely new in the life-history, as required by the antithetic theory, has, to my mind, a certain improbability. *Ex nihilo nihil fit.* We are not accustomed in natural history to see brand-new structures appearing, like morphological Melchizedeks, without father or mother. Nature is conservative, and when a new organ is to be formed it is, as every one knows, almost always fashioned out of some pre-existing organ. Hence I feel a certain difficulty in accepting the doctrine of the appearance of an intercalated sporophyte by a kind of special creation.

We can have no direct knowledge of the origin of the sporophyte in the Bryophyta themselves, for the stages, whatever they may have been, are hopelessly lost. In some of the Algæ, however, we find what most botanists recognise as at least a parallel development, even if not phylogenetically identical. (See Bower, "Antithetic Alternation," p. 361). In *Œdogonium*, for example, the oöspore does not at once germinate into a new plant, but divides up into four active zoospores, which swim about and then germinate. In *Coleochæte* the oöspore actually becomes partitioned up by cell-walls into a little mass of tissue, each cell of which then gives rise to a zoospore.

In both these genera (and many more might be added) the cell formation in the germinating oöspore has been generally regarded as representing the formation of a rudimentary sporophyte generation. If we are to apply the antithetic theory of alternation to these cases, we must assume that the zoospores produced on germination are a new formation, intercalated at this point of the life-cycle. But is this assumption borne out by the facts? I think not. In reality nothing new is intercalated at all. The "zoospores" formed from the oöspore on germination are identical with the so-called "zoogonidia," formed on the ordinary vegetative plant at all stages of its growth.

In science, as in every subject, we too easily become the slaves of language. By giving things different names we do not prove that the things themselves are different. In this case, for example, the multiplication of terms serves, in my opinion, merely to disguise the facts. The reproductive cells produced by the ordinary plant of an *Œdogonium* are identical in development, structure, behaviour, and germination with those produced by the oöspore. The term "zoogonidia" applied to the former is a "question-begging epithet," for it assumes that they are not homologous with the "zoospores" produced by the latter. I prefer to keep the old name zoospore for both, as they are identical bodies.

To my mind the point seems to be this. An *Œdogonium* (to keep to this example) can form zoospores at any stage of its development; there is one particular stage, however, at which they are *always* formed—namely, on the germination of the oöspore. Nothing new is intercalated, but the irregular and indefinite succession of sexual and asexual acts of reproduction is here tending to become regular and definite.

In *Sphæroplea*, as was well pointed out by the late Mr. Vaizey (*Annals of Botany*, vol. iv. p. 373), though his view of alternation was very different from that which I am now putting forward, the alternation is as definite as in a moss, for here, so far as we know, zoospores are only formed on the germination of the fertilised ovum. If *Sphæroplea* stood alone we might believe in the intercalation of these zoospores, as a new stage, but the comparison with *Ulothrix*, *Œdogonium*, *Bulbochæte* and *Coleochæte* shows, I think, where they came from.

The body formed from the oöspore is called by Pringshei the first neutral generation. In *Œdogonium* this has n vegetative development, for the first thing that the oöspore does is to form the asexual zoospores, and it is completely used up in the process. In other cases it is not in quite such a hurry, and here the first neutral generation has time to show itself as an actual plant. This is so in *Ulothrix*, a much more primitive form than *Œdogonium*, for its sexuality is not yet completely fixed. Here the zygospore actually germinates, forming a dwarf plant, and in this stage passes through the dull season, producing zoospores when the weather becomes more favourable. On Pringsheim's view the dwarf plant is not a new creation, but just a rudimentary *Ulothrix*, which soon passes on to spore-formation. So, too, with the cellular body formed on the germination of the oöspore of *Coleochæte*; this also is looked upon as a reduced form of thallus. On any view this genus is especially interesting, for the sporophyte remains enclosed by the tissue of the sexual generation, thus offering a striking analogy with the Bryophyta.

In the Phycomycetous Fungi—plants which have lost their chlorophyll, but which otherwise in many cases scarcely differ from Algæ—the oöspore in one and the same species may either form a normal mycelium, or a rudimentary mycelium

bearing a sporangium, or may itself turn at once into a sporangium (producing zoospores) without any vegetative development. Here it seems certain that Pringsheim's view is the right one, for all stages in the reduction of the first neutral generation lie before our eyes. Nowhere, either here or among the green Algæ, do I see any evidence for the intercalation of a *new* generation or a new form of spore on the germination of the fertilised ovum.

Pringsheim extends the same view to the higher plants. The sporogonium of a moss is for him the highly modified first neutral generation, homologous with the vegetative plant, but here specially adapted for spore-formation. I have elsewhere pointed out (NATURE, February 21, 1895) that this view has great advantages, for not only does it harmonise exactly with the actual facts observed in the green Algæ and their allies, but it also helps us to understand the astoundingly different forms which the archegoniate sporophyte may assume.

It seems to me that Pringsheim was right in regarding the fruit-formation of Florideæ as totally different from the sporophyte-formation of *Coleochæte* or the Bryophyta. The cystocarp bears none of the marks of a distinct generation, for throughout its whole development it remains in the most complete organic connection with the thallus that bears it. The whole Floridean process, often so complicated, appears to be an arrangement for effecting the fertilisation of many female cells as the result of an original impregnation by a single sperm-cell. There is here still a great field for future research; but in the light of our present knowledge there seems to be no real parallelism with the formation of a sporophyte in the higher plants.

The gap between the Bryophyta and the Algæ remains, unfortunately, a wide and deep one, and it is not probable that any Algæ at present known to us lie at all near the line of descent of the higher Cryptogams. *Riccia* is often compared with *Coleochæte*, but it is by no means evident that *Riccia* is a specially primitive form. In *Anthoceros*, which bears some marks of an archaic character, the sporophyte is relatively well developed. To those who do not accept the theory of intercalation it is not necessary to assume that the most primitive Bryophyta must have the most rudimentary sporophyte.

Apart from other differences, Bryophyta differ from most green Algæ in the fact that asexual spores are *only found* in the generation succeeding fertilisation. The spores moreover are themselves quite different from anything in Algæ, and the constancy of their formation in fours among all the higher plants from the liverworts upwards, is a fact which requires explanation. I should like to suggest to some energetic histologist a comparison of the details of spore-formation in the lower liverworts and in the various groups of Algæ, especially those of the green series. It is possible that some light might be thus thrown on the origin of tetrad-spore-formation, a subject as to which Prof. Farmer has already gained some very remarkable results. On Pringsheim's view some indications or homology between bryophytic and algal spore-formation might be expected, and anyhow the tetrads require *some* explanation.

The peculiarities of the sporophyte in the Archegoniatæ, as compared with any algal structures, depend, no doubt, on the acquirement of a terrestrial habit, while the oöphyte by its mode of fertilisation remains "tied down to a semi-aquatic life." (Bower, "Antithetic Alternation.") Prof. Bower's phrase "amphibious alternation" expresses this view of the case very happily, and indeed his whole account of the rise of the sporophyte is of the highest value, even though we may not accept his assumption as to its origin *de novo*.

I attach special weight to Prof. Bower's treatment of this subject, because he has shown how the most important of all morphological phenomena in plants, namely the alternation of generations in Archegoniatæ, may be explained as purely adaptive in origin. All Darwinians owe him a debt of gratitude for this demonstration, which holds good even if we believe the sporophyte to be the modification of a pre-existing body, and not a new formation.

Apospory and Apogamy.

We must remember that the theory of homologous alternation has twice received the strongest confirmation of which a scientific hypothesis is susceptible—that of verified prediction. In both cases Pringsheim was the happy prophet. Convinced on structural grounds of the homology of the two generations in mosses, he undertook his experiments on the moss-fruits, in the hope, as he says ("Ges. Abh." II., p. 407), that he would succeed in producing protonema from the subdivided seta of the mosses, and thus prove the *morphological* agreement of seta and moss-stem. His experiment, as everybody knows, was completely successful, and resulted in the first observed cases of *apospory*, *i.e.* the direct outgrowth of the sexual from the asexual generation.

Here he furnished his own verification; in the second case it has come from other hands. In the paper of 1877, so often referred to, he says (p. 391): "Here, however [*i.e.* in the ferns], the act of generation, that is, the formation of sexual organs and the origin of an embryo, is undoubtedly bound up with the existence of the spore, *until those future ferns are found* which I indicated as conceivable in my preliminary notice, *in which the prothallus will sprout forth directly from the frond.*"

It is unnecessary to remind English botanists that Pringsheim's hypothetical aposporous ferns are now perfectly well known in the flesh; such cases having been first observed by Mr. Druery and then fully investigated by Prof. Bower.

A very remarkable case of direct origin of the oophyte from the sporophyte has lately been described by Mr. E. J. Lowe, in a variety of *Scolopendrium vulgare*. Here the young fern-plant produced prothalli bearing archegonia as direct outgrowths from its second or third frond. The specimen had a remarkable history, for the young plants were produced from portions of a prothallus which had been kept alive and repeatedly subdivided during a period of no less than eight years. I cannot go into the interesting details here, they will be published elsewhere; but I wish to call attention to the fact that in this case the production of the sexual from the asexual generation, occurring so early in life, has no obvious relation to suppressed spore-formation, and so appears to differ essentially from the cases first described, which occurred on mature plants. I believe Mr. Lowe's case is not an altogether isolated one.

The converse phenomenon—that of apogamy—or the direct origin of an asexual plant from the prothallus without the intervention of sexual organs, has now been observed in a considerable number of ferns, the examples already known belonging to no less than four distinct families: Polypodiaceæ, Parkeriaceæ, Osmundaceæ, and Hymenophyllaceæ. In *Trichomanes alatum* Prof. Bower found that apospory and apogamy co-exist in the same plant, the sporophyte directly giving rise to a prothallus, which again directly grows out into a sporophyte; the life-cycle is thus completed without the aid either of spores or of sexual organs. Dr. W. H. Lang, who has recently made many interesting observations on apogamy, will, I am glad to say, read a paper on the subject before this Section, so I need say no more.

I must, however, express my own conviction that the facility with which, in ferns, the one generation may pass over into the other by vegetative growth, and that in both directions, is a most significant fact. It shows that there is no such hard and fast distinction between the generations as the antithetic theory would appear to demand, and in my opinion weighs heavily on the side of the homology of sporophyte and oöphyte. I cannot but think that the phenomena deserve greater attention from this point of view than they have yet received.

A mode of growth which affords a perfectly efficient means of abundant propagation cannot, I think, be dismissed as merely teratological.

Since the foregoing paragraph was first written Dr. Lang has made the remarkable discovery (already communicated to the Royal Society) that in a *Lastræa* sporangia of normal structure are produced on the prothallus itself, side by side with normal archegonia and antheridia. I cannot forbear mentioning this striking observation, of which we shall hear an account from the discoverer himself.

The strongest advocate of the homology of the prothallus with the fern plant could scarcely have ventured to anticipate such a discovery.

Relation between Mosses and Ferns.

Goebel said, in 1882: "The gap between the Bryophyta and the Pteridophyta is the deepest known to us in the vegetable kingdom. We must seek the starting-point of the Pteridophyta elsewhere than among the Muscinæ: among forms which may have been similar to liverworts, but in which the asexual generations entered from the first on a different course of development." (Schenk's "Handbuch der Botanik," vol. ii. p. 401.) I cannot help feeling that all the work which has been done since goes to confirm this wise conclusion. Attempts have been made in the most sportsmanlike manner (to adopt a phrase of Prof. Bower's)

to effect a passage over the gulf, but the gulf is still unbridged. I cannot see anywhere the slightest indication of anything like an intermediate form between the spore-bearing plant of the Pteridophyta and the spore-bearing fruit of the Bryophyta. The plant of the Pteridophyta is sometimes small and simple, but the smallest and simplest seem just as unlike a bryophytic sporogonium as the largest and most complex. On the side of the moss group, *Anthoceros* has been often cited as a form showing a certain approach towards the Pteridophytes, and Prof. Campbell in particular has developed this idea with remarkable ingenuity. An unprejudiced comparison, however, seems to me to show nothing more here than a very remote parallelism, not suggestive of affinity.

There is no reason to believe that the Bryophyta, as we know them, were the precursors of the vascular Cryptogams at all. There is a remarkable paucity of evidence for the geological antiquity of Bryophyta, though man of the mosses at any rate would seem likely to have been preserved if they existed. Brongniart said, in 1849, "The rarity of fossil mosses, and their complete absence up to now in the ancient strata, are among the most singular facts in geological botany" ("Tableau des Genres de Vegetaux Fossiles, p. 13); and since that time it is wonderful how little has been added. Things seem to point to both Pteridophyta and Bryophyta having had their origin far back among some unknown tribes of the Algæ. If we accept the homologous theory of alternation, we may fairly suppose that the sporophyte of the earliest Pteridophyta always possessed vegetative organs of some kind. The resemblance between the young sporophyte and the prothallus in some lycopods indicates that at some remote period the two generations may not have been very dissimilar. At least some such idea gives more satisfaction to my mind than the attempt to conceive of a fern-plant as derived from a sterilised group of potential spores.

The Bryophyta may have had from the first a more reduced sporophyte, the first neutral generation having, in their ancestors, become more exclusively adapted to spore-producing functions. I must not omit to mention the idea that the Bryophyta, or at any rate the true mosses, are degenerate descendants of higher forms. The presence of typical stomata on the capsule in some cases, and of somewhat reduced stomata in others, has been urged in support of this view. It is possible; but if so, from what have these plants been reduced?

Few people, perhaps, fully realise how absolutely insoluble such a problem as we have been discussing really is. I say nothing as to the mosses, which *may* have arisen relatively late in geological history. The Pteridophyta, at any rate, are known to be of inconceivable antiquity. Not only did they exist in greater development than at present in the far-off Devonian period, but at that time they were already accompanied by highly organised gymnospermous flowering-plants. Probably we are all agreed that Gymnosperms arose somehow from the vascular Cryptogams. Hence, in the Devonian epoch, there had already been time not only for the Pteridophyta themselves to attain their full development, but for certain among them to become modified into complex Phanerogams. It would not be a rash assumption that the origin of the Pteridophyta took place as long before the period represented by the plant-bearing Devonian strata as that period is before our own day. Can we hope that a mystery buried so far back in the dumb past will be revealed.

It will be understood that I do not wish to assume the *rôle* of partisan for the homologous theory of alternation. Possibly the whole question lies beyond human ken, and partisanship would be ridiculous. But I do wish to raise a protest against anything like a dogmatic statement that alternation of generations *must have been* the result of the interpolation of a new stage in the life-history. Let us, in the presence of the greatest mystery in the morphology of plants, at least keep an open mind, and not tie ourselves down to assumptions, though we may use them as working hypotheses.

HISTOLOGICAL CHARACTERS OF THE TWO GENERATIONS.

There is one histological question upon which I must briefly touch because it bears directly on the subject which we have been considering. I shall say very little, however, in view of the forthcoming discussion.

It is now well known that in animals and in the higher plants a remarkable numerical change takes place in the constituents of the nucleus shortly before the act of fertilisation. The change consists in the halving of the number of chromosomes, those rod-like bodies which form the essential part of the nucleus, and are regarded by Weismann and most biologists as the bearers of hereditary qualities. Thus in the lily the number of chromosomes in the nuclei of vegetative cells is twenty-four; in the sexual nuclei, those of the male generative cell and of the ovum, the number is twelve. When the sexual act is accomplished the two nuclei unite, and so the full number is restored and persists throughout the vegetative life of the next generation. The absolute figures are of course of no importance; the point is, the reduction to one half during the maturation of the sexual cells, and the subsequent restoration of the full number when their union takes place. I say nothing as to the details or the significance of the process, points which have been fully dealt with elsewhere, notably in an elaborate recent paper by Miss E. Sargant.

Now, in animals (so far as I am aware) and in angiospermous plants the reduction of the chromosomes takes place very shortly before the differentiation of the sexual cells. Thus in a lily the reduction takes place on the male side immediately prior to the first division of the pollen mother-cell, so that four cell-divisions in all intervene between the reduction and the final differentiation of the male generative cells. On the female side the reduction in the same plant takes place in the primary nucleus of the embryo-sac, so that here there are three divisions between the reduction and the formation of the ovum. I believe these facts agree very closely with those observed in the animal kingdom, and so far there is no particular difficulty, for we can easily understand that if the number of chromosomes is to be kept constant from one generation to another, then the doubling involved in sexual fusion must necessarily be balanced by a halving.

There are, however, a certain number of observations on Gymnosperms and archegoniate Cryptogams which appear to put the matter in a different light. Overton ("Annals of Botany," vol. vii. p. 139), first showed that in a Cycad, *Ceratozamia*, the nuclei of the prothallus or endosperm all have the half-number of chromosomes. Here then the reduction takes place in the embryo sac (or rather its mother-cell), but a a great number of cell-generations intervene between the reduction and the maturation of the ovum. In fact the whole female oöphyte shows the reduced number, while the sporophyte has the full number. The reduction takes place also in the pollen mother-cell. Further observations have extended this conclusion to some other Gymnosperms.

In *Osmunda* among the ferns there is evidence to show that reduction takes place in the spore mother-cell, and that the sexual generation has the half-number throughout. Prof. Farmer has found the same thing in various liverworts, and shown that the reduction of chromosomes takes place in the spore mother-cell; and his observations of cell-division in the two generations have afforded some direct evidence that the oöphyte has the half-number and the sporophyte the full number throughout. Prof. Strasburger fully discussed this subject before Section D at Oxford (see "Annals of Botany," vol. viii. p. 281), and came to the conclusion that the difference in number of chromosomes is a difference between the two generations as such, the sexual generation being characterised by the half-number, the asexual by the full number.

The importance of this conception for the morphologist is that an actual histological difference appears to be established between the two generations; a fact which would appear to militate against their homology. Some botanists even go so far as to propose making the number of chromosomes the criterion by which the two generations are to be distinguished. Considering that the whole theory rests at present on but few observations, I venture to think this both premature and objectionable; for nothing can be worse for the true progress of science than to rush hastily to deductive reasoning from imperfectly established premises.

The facts are certainly very difficult to interpret. Those who accept the antithetic theory of alternation suppose the sexual generation to be the older, and that in Thallophytes the plant is always an oöphyte, whether "actual" or "potential." Hence they believe that in Thallophytes the plant should show throughout the reduced number of chromosomes, reduction hypothetically taking place immediately upon the germination of the oöspore. If this were true it would lend some support to the idea of the intercalation of the sporophyte, but at present there is not the slightest evidence for these assumptions. On the contrary, in the only Thallophyte in which chromosome-counting

has been successfully accomplished (*Fucus*), Prof. Farmer and Mr. Williams find exactly the reverse; the plant has throughout the *full* number of chromosomes; reduction first takes place in the oögonium, immediately before the maturation of the ova, and on sexual fusion the full number is restored, to persist throughout the vegetative life of the plant. *Fucus* is, no doubt, a long way off the direct line of descent of Archegoniatæ, but still it is a striking fact that the only direct evidence we have goes dead against the idea that the sexual generation (and who could call a Fucus-plant anything else but sexual?) necessarily has the reduced number of chromosomes. This fact is indeed a rude rebuff to deductive morphology.

I am disposed to regard the different number of chromosomes in the two generations observed in certain cases among Archegoniatæ not as a primitive but as an acquired phenomenon, perhaps correlated with the definiteness of alternation in the Archegoniatæ as contrasted with its indefiniteness in Thallophytes. In *Fucus*, in flowering plants, and in animals the *soma* or vegetative body has the full number of chromosomes. With these the sporophyte of the Archegoniatæ agrees; it is the oöphyte which appears to be peculiar in possessing the half-number, so that if the evidence points to intercalation at all, it would seem to suggest that the oöphyte is the intercalated generation—obviously a *reductio ad absurdum*. I do not think we are as yet in a position to draw any morphological conclusions from these minute histological differences, interesting as they are.

The question how the number of chromosomes is kept right in cases of apospory and of apogamy is obviously one of great interest, and I am glad to say that it is receiving attention from competent observers.

Sexuality of Fungi.

Only a few years ago De Bary's opinion that the fruit of the ascus-bearing Fungi is normally the result of an act of fertilisation was almost universally accepted, especially in this country. Although the presence of sexual organs had only been recorded in comparatively few cases, and the evidence for their functional activity was even more limited, yet the conviction prevailed that the ascocarp is at least the homologue of a sexually produced fruit. The organ giving rise to the ascus or asci was looked upon as homologous with the oögonium of the Peronosporeæ, the supposed fertilising organ either taking the form of an antheridial branch as in that group, or, as observed by Stahl in the lichen *Collema*, giving rise to distinct male cells, or spermatia. More recently there has been a complete revolution of opinion on this point, and a year ago or less most botanists probably agreed that the question of the sexuality of the Ascomycetes had been settled in a negative sense. This change was due, in the first place, to the influence of Brefeld, who showed, in a great number of laborious investigations, that the ascus-fruit may develop without the presence of anything like sexual organs; while Möller proved that the supposed male cells of lichens are in a multitude of cases nothing but conidia, capable of independent germination.

The view thus gained ground that all the higher Fungi are asexual plants, fertilisation only occurring in the lower forms, such as the Peronosporeæ and Mucorineæ, which have not diverged far from the algal stock. The ascus, in particular, is regarded by this school as homologous with the asexual sporangium of a *Mucor*. This theory has been brilliantly expounded in a remarkable book by Von Tavel, which we cannot but admire as a model of clear morphological reasoning, whether its conclusions be ultimately adopted or not.

Still, it must be admitted that the Brefeld school were rather apt to ignore such pieces of evidence as militated against their views, and consequently their position was insecure so long as those hostile posts were left uncaptured.

Quite recently the whole question has been reopened by the striking observations of Mr. Harper, an American botanist working at Bonn.

Zopf, in 1890 (Die Pilze, "Schenk's Handbuch der Botanik," Bd. iv. p. 341), pointed out that up to that time it had not been possible in any Ascomycete to demonstrate a true process of fertilisation by strictly scientific evidence, namely, by observing the fusion of the nuclei of the male and female elements. Exactly the proof demanded has now been afforded by Mr. Harper's observations, for in a simple Ascomycete, *Sphærotheca castagnei*, the parasite causing the hop-mildew, he has demonstrated in a manner which appears to be conclusive the fusion of the nucleus of the antheridium with that of the ascogonium (*Berichte der deutschen bot. Gesellschaft*, vol. xiii., January 29, 1896). It is impossible to evade the force of this evidence, for the fungus in question is a perfectly typical Ascomycete, though exceptionally simple, in so far as only a single ascus is normally produced from the ascogonium. It is unnecessary to point out how important it is that Mr. Harper's observations should be confirmed and extended to other and more complex members of the order. In the mean time the few who (unlike your President) had not bowed the knee to Brefeld may rejoice!

It is impossible to pursue the various questions which press upon one's mind in considering the morphology of the Fungi. The occurrence not only of cell-fusion, but of nuclear fusion, apart from any definite sexual process, now recorded in several groups of Fungi, urgently demands further inquiry. Such unions of nuclei have been observed in the basidia of Agarics, the teleutospores of Uredineæ, and even in the asci of the Ascomycetes. That such a fusion is not necessarily, as Dangeard (*Le Botaniste*, vols. iv. and v.) has supposed, of a sexual nature, seems to be proved by the fact that it occurs in the young ascus of *Sphærotheca* long after the true act of fertilisation has been accomplished. It is possible, however, that these phenomena may throw an important side-light on the significance of the sexual act itself.

Another question which is obviously opened up by the new results is that of the homologies of the ascus. The observations of Lagerheim ("Pringsheim's Jahrbuch f. Wiss Bot.," 1892), on *Dipodascus* point to the sexual origin of a many-spored sporangium not definitely characterised as an ascus. On the other hand, not only sporangia, but true asci are known to arise in a multitude of cases direct from the mycelium. It is of course possible that as regards the asci these are cases of reduction or apogamy; on the other hand, it is not wholly impossible that the asci may turn out to be really homologous with a sexual sporangia, even though their development may often have become associated with the occurrence of a sexual act. However this may be, there is at present no reason to doubt that a very large proportion of the Fungi are, at least fnnctionally, sexless plants.

Chalazogamy.

Among the most striking results of recent years bearing on the morphology of the higher plants, Treub's discovery of the structure of the ovule and the mode of fertilisation in *Casuarina* must undoubtedly be reckoned. The fact that the pollen tube in this genus does not enter the micropyle, but travels through the tissues of the ovary to the chalaza, thus reaching the base of the embryo-sac, was remarkable enough in itself, and when considered in connection with the presence of a large sporogenous tissue producing numerous embryo-sacs, appeared to justify the separation of this order from other angiosperms. Then came the work of Miss Benson in England, and of Nawaschin in Russia, showing that these remarkable peculiarities are by no means confined to *Casuarina*, but extend also in various modifications to several genera of the Cupuliferæ and Ulmaceæ. They are not, however, constant throughout these families, so that we are no longer able to attach to these characters the same fundamental systematic importance which their first discoverer attributed to them. It is remarkable, however, that these departures from the ordinary course of angiospermous development occur in families some of which have been believed on other grounds to be among the most primitive Dicotyledons.

Evidence of Descent derived from Fossil Botany.

At the beginning of this Address I spoke of the importance of the comparatively direct evidence afforded by fossil remains as to the past history of plants. It may be of interest if I endeavour to indicate the directions in which such evidence seems at present to point.

It was Brongniart who in 1828 first arrived at the great generalisation that "nearly all of the plants living at the most ancient geological epochs were Cryptogams" (Williamson, "Reminiscences of a Yorkshire Naturalist," 1896, p. 198), a discovery of unsurpassed importance for the theory of evolution, though one which is now so familiar that we almost take it for granted. Those palæozoic plants which are not Cryptogams are Gymnosperms, for the angiospermous flowering plants only make their appearance high up in the secondary rocks. Even

the Wealden flora, recently so carefully described by Mr. Seward, one of the secretaries to this Section, has as yet yielded no remains referable to Angiosperms, though this is about the horizon at which we may expect their earliest trace to be found.

Attention has already been called to the enormous antiquity of the higher Cryptogams—the Pteridophyta—and to the striking fact that they are accompanied, in the earliest strata in which they have been demonstrated with certainty, by well-characterised Gymnosperms. The Devonian flora, so far as we know it, though an early, was by no means a primitive one, and the same statement applies still more strongly to the plants of the succeeding Carboniferous epoch. The palæozoic Cryptogams, as is now well known, being the dominant plants of their time, were in many ways far more highly developed than those of our own age; and this is true of all the three existing stocks of Pteridophyta, Ferns, Lycopods, and Equisetineæ.

We cannot therefore expect any *direct* evidence as to the origin of these groups from the palæozoic remains at present known to us, though it is, of course, quite possible that the plants in question have sometimes retained certain primitive characters, while reaching in other respects a high development. For example, the general type of anatomical structure in the young stems of the Lepidodendreæ was simpler than that of most Lycopods at the present day, though in the older trunks the secondary growth, correlated with arborescent habit, produced a high degree of complexity. On the whole, however, the interest of the palæozoic Cryptogams does not consist in the revelation of their primitive ancestral forms, but rather in their enabling us to trace certain lines of evolution further upward than in recent plants. From the Carboniferous rocks we first learn what Cryptogams are capable of. In descending to the early strata we do not necessarily trace the trunk of the genealogical tree to its base; on the contrary, we often light on the ultimate twigs of extensive branches which died out long before our own period.

In a lecture which I had the honour of giving last May before the Liverpool Biological Society, I pointed out how futile the search for "missing links" among fossil plants is likely to be. The lines of descent must have been so infinitely complex in their ramification that the chances are almost hopelessly great against our happening upon the direct ancestors of living forms. Among the collateral lines, however, we may find invaluable indications of the course of descent.

Fossil botany has revealed to us the existence in the Carboniferous epoch of a fourth phylum of vascular Cryptogams quite distinct from the three which have come down—more or less reduced—to our own day. This is the group of Sphenophylleæ, plants with slender ribbed stems, superposed whorls of more or less wedge-shaped leaves, and very complex strobili with stalked sporangia. The group to a certain extent combines the characters of Lycopods and Horsetails, resembling the former in the primary anatomy, and the latter, though remotely, in external habit and fructification. Like so many of the early Cryptogams, *Sphenophyllum* possessed well-marked cambial growth. One may hazard the guess that this interesting group may have been derived from some unknown form lying at the root of both Calamites and Lycopods. The existence of the Sphenophylleæ certainly suggests the probability of a common origin for these two series.

In few respects is the progress made recently in fossil botany more marked than in our knowledge of the affinities of the Calamarieæ. Even so recently as the publication of Count Solms-Laubach's unrivalled introduction to "Fossil Botany," the relation of this family to the Horsetails was still so doubtful that the author dealt with the two groups in quite different parts of his book. This is never likely to happen again. The study of vegetative anatomy and morphology on the one hand, and of the perfectly preserved fructifications on the other, can leave no doubt that the fossil Calamarieæ and the recent Equiseta belong to one and the same great family, of which the palæozoic representatives are, generally speaking, by far the more highly organised. This is not only true of their anatomy, which is characterised by secondary growth in thickness just like that of a Gymnosperm, but also applies to the reproductive organs, some of which are distinctly heterosporous. In the genus *Calamostachys* we are, I think, able to trace the first rise of this phenomenon.

The external morphology of the cones is also more varied and usually more complex than that of recent Equiseta, though in some Carboniferous forms, as in the so-called *Calamostachys tenuissima* of Grand' Eury, we find an exactly Equisetum-like arrangement.

The position of the Sigillariæ as true members of the Lycopod group, is now well established. The work of Williamson proved that there is no fundamental distinction between the vegetative structure of *Lepidodendron*, which has always been recognised as lycopodiaceous, and that of *Sigillaria*. Secondary growth in thickness, the character which here, as in the case of the Calamodendreæ, misled Brongniart, is the common property of both genera. Then came Zeiller's discovery of the cones of *Sigillaria*, settling beyond a doubt that they are heterosporous Cryptogams. A great deal still remains to be done, more especially as to the relation of *Stigmaria* to the various types of lycopodiaceous stem. At present we are perhaps too facile in accepting *Stigmaria ficoides* as representing the underground organs of almost any carboniferous Lycopod.

We are now in possession of a magnificent mass of data for the morphology of the palæozoic lycopods, and have, perhaps, hardly yet realised the richness of our material. I refer more especially to specimens with structure, on which, here as elsewhere, the scientific knowledge of fossil plants primarily depends.

It is scarcely necessary to repeat what has been said so often elsewhere, that the now almost universal recognition of the cryptogamic nature of Calamodendreæ and Sigillariæ is a splendid triumph for the opinions of the late Prof. Williamson, which he gallantly maintained through a quarter of a century of controversy.

Perhaps, however, the keenest interest now centres in the Ferns and fern-like plants of the Carboniferous epoch. No fossil remains of plants are more abundant or more familiar to collectors, than the beautiful and varied fern-fronds from the older strata. The mere form, and even the venation of these fronds, however, really tell us little, for we know how deceptive such characters may be among recent plants. In a certain number of cases, discovery of the fructification has come to our aid, and were sori are found we can have no more doubt as to the specimens belonging to true Ferns. The work of Stur and Zeiller has been especially valuable in this direction, and has revealed the interesting fact that a great many of these early Ferns showed forms of fructification now limited to the small order Marattiaceæ. I think perhaps the predominance of this group has been somewhat exaggerated, but at least there is no doubt that the marattiaceous type was much more important then than now, though it by no means stood alone. In certain cases the whole fern-plant can be built up. Thus Zeiller and Renault have shown that the great stems known as *Psaronius*, the structure of which is perfectly preserved, bore fronds of the *Pecopteris* form, and that similar *Pecopteris* fronds produced the fructification of *Asterotheca*, which is of a marattiaceous character. Hence, for a good many Carboniferous and Permian forms there is not the slightest doubt as to their fern-nature, and we can even form an idea of the particular group of Ferns to which the affinity is closest.

I will say nothing more as to the true Ferns, though they present innumerable points of interest, but will pass on at once to certain forms of even greater importance to the comparative morphologist.

A considerable number of palæozoic plants are now known which present characters intermediate between those of Ferns and Cycadeæ. I say *present intermediate characters*, because that is a safe statement; we cannot go further than this at present, for we do not yet know the reproductive organs of the forms in question.

In *Lyginodendron*, the vegetative organs of which are now completely known, the stem has, on the whole, a cycadean structure; the anatomy, which is preserved with astonishing perfection, presents some remarkable peculiarities, the most striking being that the vascular bundles of the stem have precisely the same arrangement of their elements as is found in the leaves of existing Cycads, but nowhere else among living plants. The roots also, though not unlike those of certain ferns in their primary organisation, grew in thickness by means of Cambian, like those of a Gymnosperm. On the other hand, the leaves of *Lyginodendron* are typical fern-fronds, having the form characteristic of the genus *Sphenopteris*, and being probably identical with the species *S. Hœninghausi*. Their minute structure is also exactly that of a fern-frond, so that no botanist would doubt that he had to do with a Fern if the leaves alone were before him

This plant thus presents an unmistakable combination of cycadian and fern-like characters. Another and more ancient genus, *Heterangium*, agrees in many details with *Lyginodendron*, but stands nearer the ferns, the stem in its primary structure resembling that of a *Gleichenia*, though it grows in thickness like a cycad. These intermediate characters led Prof. Williamson and myself to the conclusion that these two genera were derived from an ancient stock of Ferns, combining the characters of several of the existing families, and that they had already considerably diverged from this stock in a cycadean direction. I believe that recent investigations, of which I hope we shall hear more from Mr. Seward, tend to supply a link between *Lyginodendron* and the more distinctly cycadean stem known as Cycadoxylon.

Heterangium first appears in the Burntisland beds, at the base of the Carboniferous system; from a similar horizon in Silesia, Count Solms-Laubach has described another fossil, *Perotopitys Bucheana*, the vegetative structure of which also shows, though in a different form, a striking union of the characters of Ferns and Gymnosperms. Count Solms shows that this genus cannot well be included among the Lyginodendreæ, but must be placed in a family of its own, which, to use his own words, "increases the number of extinct types which show a transition between the characters of Filicineæ and of Gymnosperms, and which thus might represent the descendants in different directions of a primitive group common to both." (*Bot. Zeitung*, 1893, p. 207.)

Another intermediate group, quite different from either of the foregoing, is that of the Medulloseæ, fossils most frequent in the Upper Carboniferous and Permian strata. The stems have a remarkably complicated structure, built up of a number of distinct rings of wood and bast, each growing by its own cambium. Whether these rings represent so many separate primary cylinders, like those of an ordinary polystelic Fern, or are entirely the product of anomalous secondary growth, is still an open question, on which we may expect more light from the investigations of Count Solms. In any case, these curious stems (which certainly suggest in themselves some relation to Cycadeæ) are known to have borne the petioles known as *Myeloxylon*, which have precisely the structure of cycadean petioles. (Seward, "Annals of Botany," vol. vii. p. 1.)

Renault has further brought forward convincing evidence that these *Myeloxylon* petioles terminated in distinctly fern-like foliage, referable to the form-genera *Alethopteris* and *Neuropteris*. Hence it is evident that the fronds of these types, like some specimens of *Sphenopteris*, cannot be accepted as true ferns, but may be strongly suspected of belonging to intermediate groups between Ferns and Cycads.

It is not likely (as has been repeatedly pointed out elsewhere) that any of these intermediate forms are really direct ancestors of our existing Cycads, which certainly constitute only a small and insignificant remnant of what was once a great class, derived, as I think the evidence shows, from fern-like ancestors, probably by several lines of descent.

One of the greatest discoveries in fossil botany was undoubtedly that of the Cordaiteæ—a fourth family of Gymnosperms, quite distinct from the three now existing, though having certain points in common with all of them. They are much the most ancient of the four stocks, extending back far into the Devonian. Nearly all the wood of Carboniferous age, formerly referred to Coniferæ under the name of *Dadoxylon* or *Araucarioxylon*, belonged to these plants. Thanks chiefly to the brilliant researches of Renault and Grand' Eury, the structure of these fine trees is now known with great completeness. The roots and stems have a coniferous character, but the latter contain a large, chambered pith different from anything in that order. The great simple lanceolate or spatulate leaves, sometimes a yard long, were traversed by a number of parallel vascular bundles, each of which has the exact structure of a foliar bundle in existing Cycadeæ. This type of vascular bundle is evidently one of the most ancient and persistent of characters. Both the male and female flowers (*Cordaianthus*) are well preserved in some cases. The morphology of the former has not yet been cleared up, but the stamen, consisting of an upright filament bearing 2–4 long pollen-sacs at the top, is quite unlike anything in Cycadeæ; a comparison is possible either with *Gingko* or with the Gnetaceæ.

In the female flowers—small cones—the axillary ovules appear to have two integuments, a character which resembles Gnetaceæ rather than any other Gymnosperms. Renault's famous discovery of the prothallus in the pollen-grains of *Cordaites* indicates the persistence of a cryptogamic character; but it cannot be said that the group as a whole bears the impress of primitive simplicity, though it certainly combines in a remarkable way the characters of the three existing orders of the Gymnosperms.

There is one genus, *Poroxylon*, fully and admirably investigated by Messrs. Bertrand and Renault, which from its perfectly preserved vegetative structure (and at present nothing else is known) appears to occupy an intermediate position between the Lyginodendreæ and the Cordaiteæ. The anatomy of the stem is almost exactly that of *Lyginodendron*, the resemblance extending to the minutest details, while the leaves seem to closely approach those of *Cordaites*. *Poroxylon* is at present known only from the Upper Carboniferous, so we cannot regard it as in any way representing the ancestors of the far more ancient Cordaiteæ. The genus suggests, however, the possibility that the Cordaiteæ and the Cycadeæ (taking the latter term in its wide sense) may have had a common origin among forms belonging to the filicinean stock. It is also possible that the Cordaiteæ, or plants allied to them, may in their turn have given rise to both Coniferæ and Gnetaceæ.

It is unfortunate that at present we do not know the fructification of any of the fossil plants which appear to be intermediate between ferns and Gymnosperms. Sooner or later the discovery will doubtless be made in some of these forms, and most interesting it will be. M. Renault's *Cycadospadix* from Autun appears to show that very cycad-like fructifications already existed in the later Carboniferous period, and numerous isolated seeds point in the same direction, but we do not know to what plants they belonged.

I think we may say that such definite evidence as we already possess decidedly points in the direction of the origin of the Gymnosperms generally from plants of the Fern series rather than from a lycopodiaceous stock.

I must say a few words before concluding on the cycad-like fossils which are so striking a feature of mesozoic rocks, although I feel that this is a subject with which my friend Mr. Seward is far more competent to deal. Both leaves and trunks of an unmistakably cycadean character are exceedingly common in many mesozoic strata, from the Lias up to the Lower Cretaceous. In some cases the structure of the stem is preserved, and then it appears that the anatomy as well as the external morphology is, on the whole, cycadean, though simpler, as regards the course of the vascular bundles, than that of recent representatives of the group.

Strange to say, however, it is only in the rarest cases that fructifications of a truly cycadean type have been found in association with these leaves and stems. In most cases, when the fructification is accurately known, it has turned out to be of a type totally different from that of the true Cycadeæ, and much more highly organised. This is the form of fructification characteristic of *Bennettites*, a most remarkable group, the organisation of which was first revealed by the researches of Carruthers, afterwards extended by those of Solms-Laubach and Lignier. The genus evidently had a great geological range, extending from the Middle Oölite (or perhaps even older strata) to the Lower Greensand. Probably, all botanists are agreed in attributing cycadean affinities to the Bennettiteæ, and no doubt they are justified in this. Yet the cycadean characters are entirely vegetative and anatomical; the fructification is as different as possible from that of any existing cycad, or, for that matter, of any existing Gymnosperm. At present, only the female flower is accurately known, though Count Solms has found some indications of anthers in certain Italian specimens. The fructification of the typical species, *B. Gibsonianus*, which is preserved in marvellous perfection in the classical specimens from the Isle of Wight, terminates a short branch inserted between the leaf-bases, and consists of a fleshy receptacle bearing a great number of seeds seated on a long pedicel with barren scales between them. The whole mass of seeds and intermediate scales is closely packed into a head, and is enclosed by a kind of pericarp formed of coherent scales, and pierced by the micropylar terminations of the erect seeds. Outside the pericarp, again, is an envelope of bracts which have precisely the structure of scale-leaves in cycads. The internal structure of the seeds is perfectly preserved, and strange to say, they are nearly, if not quite, exalbuminous, practically the whole cavity being occupied by a large dicotyledonous embryo.

This extraordinary fructification is entirely different from that of any other known group of plants, recent or fossil, and charac-

terises the Bennettiteæ, as a family perfectly distinct from the Cycadeæ, though probably, as Count Solms-Laubach suggests, having a common origin with them at some remote period. The Bennettiteæ, while approaching Angiosperms in the complexity of their fruit, retain a filicinean character in their ramenta, which are quite like those of ferns, and different from any other form of hair found in recent Cycadeæ. Probably the bennettitean and cycadean series diverged from each other at a point not far removed from the filicinean stock common to both.

I hope that the hasty sketch which I have attempted of some of the indications of descent afforded by modern work on fossil plants may have served to illustrate the importance of the questions involved and to bring home to botanists the fact that phylogenetic problems can no longer be adequately dealt with without taking into account the historical evidence which the rocks afford us.

Before leaving this subject I desire to express the great regret which all botanists must feel at the recent loss of one of the few men in England who have carried on original work in fossil botany. At the last meeting of the Association we had to lament the death, at a ripe old age, of a great leader in this branch of science, Prof. W. C. Williamson. Only a few weeks ago we heard of the premature decease of Thomas Hick, for many years his demonstrator and colleague. Mr. Hick profited by his association with his distinguished chief, and made many valuable original contributions to palæobotany (not to mention other parts of botanical science), among which I may especially recall his work, in conjunction with Mr. Cash, on *Astromyelon* (now known to be the root of Calamites), on the leaves and on the primary structure of the stem in Calamites, on the structure of *Calamostachys*, on the root of *Lyginodendron*, and on a new fossil probably allied to *Stigmaria*. His loss will leave a gap in the too thin ranks of fossil-botanists; but we may hope that the subject, now that its importance is beginning to be appreciated, will be taken up by a new generation of enthusiastic investigators.

Conclusion

To my mind there is a wonderful fascination in the records of the far-distant past in which our own origin, like that of our distant cousins the plants, lies hidden. If any fact is brought home to us by the investigations of modern biology, it is the conviction that all life is one: that, as Nägeli said, the distance from man to the lowest bacterium is less than the distance from the lowest bacterium to non-living matter.

In all studies which bear on the origin and past history of living things there is an element of human interest—

> "Hence, in a season of calm weather,
> Though inland far we be,
> Our souls have sight of that immortal sea
> Which brought us hither."

The problems of descent, though strictly speaking they may often prove insoluble, will never lose their attraction for the scientifically guided imagination.

THE CONWAY EXPEDITION TO SPITZBERGEN.

THE *Times* of September 18 published an account of a conversation which Mr. Trevor-Battye, on his return from his recent journey in Spitzbergen, had with a representative of Reuter's Agency. To this report we are indebted for the following particulars. As will be remembered, Mr. Trevor-Battye was a member of Sir Martin Conway's expedition (an account of the doings of a section of which appeared in NATURE of September 10, from the pen of Dr. J. W. Gregory), and, as arranged, left Sir Martin Conway, Dr. Gregory, and Mr. Garwood, in company with Mr. Conway, the artist, and Pedersen, of Tromsö, near Advent Bay for the purpose of exploring some of the northern parts of the island. The first object was to explore Dickson Bay, the most northerly bay in Ice Fjord, the northern part of which had never been mapped. In this work the explorers seem to have met with very considerable difficulties from flowing ice and the remains of the old winter pack. However, they landed at a place on the western shore, and spent the night. In the morning, the ice having opened a little, Mr. Trevor-Battye and Pedersen crossed to the other side, being anxious to find out something of the character of the country which separates Ice Fjord from the sea lying to the north. At the north end they found the tide was out, and great stretches of mud of a very tenacious character were to be seen. In the distance, running north-west, appeared what seemed to be a valley; but, at a nearer view, it proved not to be a valley at all, but an enormous glacier, the front of which was masked by an immense and intricate moraine. The glacier, in striking contrast to the majority of glaciers, is a retreating one, and is slowly dying back. On reaching it, the explorers found it a mile and a half wide, and many miles in length. Pedersen, being anxious about his boat, returned to her at this stage, and Mr. Trevor-Battye went on alone, and presently climbed the snout of a rounded glacier, by which he hoped to be able to effect a crossing. It was, however, badly crevassed, the crevasses becoming wider and more formidable at every step. In his own words: "I had not expected to find ice, and so was not prepared, not even having a stick or a gun with me. I wanted to push on, however, although aware of the fact that the undertaking was rash, and one which, under the circumstances, no Alpine guide would have attempted. I went some distance further, but, sinking to my knees on a snow-bridge half-spanning a crevasse, I had to reach the other side by flinging myself forward. Later, while standing at the edge of another crevasse, a large body of solid ice, which was jammed between its walls, fell with a roar as I was going to walk across it. A little ahead I could see the col, from which I knew I should have sight of the sea; but I found it impossible to proceed without proper ice tools, for the crevasses between me and that point were masked by deep snow, and I felt any further attempts to be quite unjustifiable. I had now reached a height of 1800 feet—not of mountain, but a gradual rise of ice-river from the sea. The return journey I found more difficult, as the crevasses had to be met down hill, and a slip upon their rounded edges would have been fatal. Finally, I rejoined Pedersen after a walk of twenty-two hours. We then returned to Cape Wärn, and explored the western bay of Ice Fjord. According to Nordenskiöld's map, on which our Admiralty chart is based, a large island occupies the centre of this bay; but, after cruising about for two days, we found to our surprise that it no longer existed as an island. The glacier—which, by the way, we named 'Splendid Glacier'—had encroached to such an extent, and so rapidly, that it had entirely filled up one neck of the bay, and had also covered two-thirds of the island. In a few years' time the head of the bay will be completely obliterated."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. CARL VON KUPFFER, Professor of Anatomy in the University of Munich, has been elected Rector of that University for the coming year.

MR. J. AIREY, of the Leeds Organised Science School, has been appointed science master of the Rhondda Intermediate School at Porth.

MR. F. T. HOWARD, Professor of Geology in Cardiff University College, has been appointed one of her Majesty's inspectors of schools.

MR. H. J. MACKINDER will deliver, at Gresham College, under the auspices of the University Extension Society, a course of twenty-five lectures on "The Geography of Europe, Asia, and Northern Africa," beginning on October 5, at six o'clock.

DR. E. SYMES THOMPSON, Gresham Professor of Medicine, will deliver lectures on "Vaccination," on October 6 and 7, and on "The New Photography," on October 8 and 9. The lectures, for which no charge for admission is made, will be given at six o'clock each evening in Gresham College, Basinghall Street, E.C.

THE Councils of University College and of King's College, London, have, in conjunction with the Technical Education Board of the London County Council, arranged a number of courses to be held in the evenings for those students who are engaged in the day-time. The courses are to be of the same standard as the day classes, and admission will be confined to students who have already made some advance in the knowledge of the subjects. At University College there will be lectures on mechanical engineering, by Prof. Hudson Beare, commencing October 12; electrical engineering, by Prof. Fleming, commencing October 13; and practical chemistry, by Mr. C. F. Cross, commencing November 1. At King's College the special evening classes for advanced students are: Civil

engineering, by Prof. Robinson, beginning Monday, October 5; architecture, by Prof. Banister Fletcher, beginning on Wednesday, October 7; experimental and practical physics, beginning on Monday, October 5, under the direction of Prof. Adams, F.R.S.; pure mathematics—higher mathematics—by Prof. Hudson, beginning on Tuesday, October 6; and a free Saturday morning class for elementary teachers—strength of materials and theory of machines—by Prof. Capper, beginning Saturday, October 17. Application to join any of the above classes should be made, as soon as possible, to the Professors who will conduct the courses. The formation of the classes is a new feature of the work of the London Technical Education Board, and it is one which will advance technical education in the right direction.

SCIENTIFIC SERIALS.

Wiedemann's Annalen der Physik und Chemie, No. 9.—Effect of light on spark discharges, by E. Warburg. This effect is not a direct action, but is the consequence of the shortening of a process preceding the spark discharge, and this shortening is brought about by illumination. The author studied the shortening by applying the difference of potential more or less rapidly, and finding the lowest difference of potential capable of producing discharge within five minutes, this being the greatest delay observed. The discharge potential thus found he calls the statical discharge potential, to distinguish it from the dynamic discharge potential producing sparks when the current surges to and fro. The experiments made by the author show that the statical discharge potential is not materially influenced by illumination. But when a difference of potential nearly seven times as high is applied for a few thousandths of a second only, it always produces discharge when the kathode is illuminated by an arc lamp, and not in the dark. The range of potentials at which discharge only takes place occasionally is very small in the case of illumination, but large in the dark. This explains why a telephone connected with an illuminated spark gap gives a purer note than when it is not illuminated.—Electric refractive indices of water and aqueous solutions, by P. Drude. For oscillations of the frequency of 4×10^8 per second the square of the electric index of refraction at 17° C. is 81·67. Water possesses slight normal dispersion, since the square is 80·60 for a frequency of $1{\cdot}5 \times 10^8$, and 83·6 for 8×10^8. Between 0° and 26° the change of n^2 is proportional to the temperature. It decreases by 0·367 per degree. At higher temperatures the decrease is slower. The refractive indices of dilute aqueous solutions are very nearly the same as those of water.—Dilute ferromagnetic amalgams, by H. Nagaoka. In fields of less than 20 C.G.S. units the magnetisation of iron amalgams shows a discontinuity at the melting-point. On heating an amalgam containing 1·78 per cent. of iron, produced by electrolysis, up to its melting-point (−38° C.), the intensity of magnetisation in a field of 16 units gradually increased. It suddenly attained a maximum on melting, and gradually diminished on further heating.—Influence of pulling and pushing forces upon magnetic properties, by G. S. Meyer. Cobalt also shows the effect discovered in iron by Villari of a maximum of magnetic intensity when under a certain force. In nickel and cobalt tension produces an E.M.F. identical in direction with that produced by longitudinal magnetisation.—An attempt to liquefy helium, by K. Olszewski. (See p. 377.) Helium cannot be liquefied by the most powerful methods yet available. It is more permanent than hydrogen, probably owing to its monatomic structure, and is on that account valuable as a thermometric substance at very low temperatures. A comparison of a helium and a hydrogen thermometer shows, however, that hydrogen has normal expansion as far as −234·5° C., its critical temperature, and is therefore available for thermometric use down to that point.

Bollettino della Società Sismologica Italiana, vol. ii., 1896, No. 3.—On the Benevento earthquake of March 14, 1702, by M. Baratta. A discussion of the earthquake founded on three old documents recently discovered, and of its relations to the Benevento earthquakes of June 1688 and September 1885.—Present state of the endogenous phenomena in the Eolian islands, by A. Riccò.—Considerations on recording seismic apparatus and modification of the two-component microseismograph, by G. Vicentini and G. Pacher. A reprint of a paper already noticed in NATURE.—Summary of the principal eruptive phenomena in Sicily and the adjacent islands during the six months January to June, 1896, by S. Arcidiacono.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 21.—M. A. Cornu in the chair.—The President announced the loss that the Academy had sustained in the death of M. Fizeau, and the meeting was adjourned in consequence.

NEW SOUTH WALES.

Linnean Society, July 29.—Mr. Henry Deane, President, in the chair.—Appendix to the Australian *Clivinides* (fam. *Carabidæ*), by Thomas G. Sloane. Since his paper was read (at the June meeting) the author has had the opportunity of examining the *Clivinides* of King's Sound, W.A., and its vicinity, in the Macleay Museum. The collection comprises sixteen species, of which two are described as new.—Descriptions of new species of Australian Coleoptera, by Arthur M. Lea. Two genera and thirty-four species belonging to the families *Tenebrionidæ* and *Curculionidæ* are described as new. Two very interesting species are noted—an apterous *Pterohelæus* and a Cossonid having an 8-jointed funicle.—Descriptions of some new *Araneidæ* of New South Wales, No. 6, by W. J. Rainbow. Eight species, comprising representatives of the genera *Nephila*, *Epeira*, *Dolomedes*, and *Actinoups*, are described as new. The last named is specially interesting from the fact that it is the first of the genus recorded from Australia. Five of the spiders described are remarkable for their protective colouration or mimicry; in addition to these, numerous other examples are instanced. After summing up all the facts recorded, the writer concludes by dividing the *Araneidæ* into two groups, viz.: (1) (*a*) spiders whose colouration and (*b*) formation is protective: and (2) spiders that mimick, (*a*) animate or (*b*) inanimate objects, and (*c*) whose colours are attractive.—Description of a new species of *Ablepharus* from Victoria, with critical remarks on two other Australian lizards, by A. H. S. Lucas and C. Frost. *Ablepharus rhodonoides*, sp.n., from Mildura, is allied to *A. greyi*, Gray, by the head-scaling, but in habit it resembles species like *A. muelleri*, Fischer, and *A. lineatus*, Bell, which are remarkable for the reduction in the size of the limbs, as well as in the number of the digits. *A. greyi*, described from West Australia, is recorded from the Boggabri District, N.S.W. *Hemisphæriodon tasmanicum*, Lucas and Frost (Proceedings, 1893, p. 227), as the outcome of the examination of series of additional specimens, is now reduced to a variety of the very variable *Homolepida casuarineæ*, D. and B.—On a new genus and three new species of mollusca from New South Wales, New Hebrides, and Western Australia, by John Brazier.

CONTENTS.

THURSDAY, OCTOBER 8, 1896.

THE ALTERNATE CURRENT TRANSFORMER.

The Principles of the Transformer. By Frederick Bedell, Ph.D. 8vo. Pp. xii + 400. (New York: The Macmillan Company. London: Macmillan and Co., Ltd., 1896.)

IN a work coming to us from one of the principal technical colleges in the United States, and on a subject which has been occupying the attention of electrical engineers for at least fourteen years, one would naturally expect to find a well-considered treatment based on the concentrated essence of practical experience, and embodied in a form which should definitely guide design and construction. It was therefore with a feeling of disappointment that we found so large a portion of this volume devoted to a class of investigations which are nothing more than elaborate mathematical exercises in the geometry of periodic quantities. The experimental researches of numerous engineers and electricians in the last decade have completely elucidated the general nature of the operations going on in the alternate current transformer, and as a practical art its construction has been brought to a very high degree of perfection. The demand for transformers has developed of late years an entirely new branch of the iron industry, viz. the manufacture of transformer iron, on which much depends, and with a large body of experience to fall back upon, the manufacturer can now work up to a definite and exacting specification. In the presence of other well-known text-books which deal with the properties of periodic currents, the general construction of the transformer, and its employment in electric distribution, there was hardly room for a volume of the size before us unless marked by some distinct novelty of treatment, or the development of a theory strictly brought to the test of experimental confirmation. Unfortunately we find neither of these two requirements here fulfilled. The earlier portions of the book are occupied with an elementary discussion of the properties of simple harmonic currents. It may be assumed that for students beginning to study the properties of alternating currents some amount of this information is necessary, but for the training of engineering students it is above all things necessary that the fundamental definitions should be so laid down as to lead immediately to clear notions of how the quantities concerned are measured, and numerical examples be added. This, however, is just what is not done in this book. The definitions of such leading terms as magnetic induction, magnetic force, inductance, coefficient of self-induction, are given in a way which is likely to produce a considerable amount of obscuration in the mind of a beginner. Take as an instance the definition of the coefficient of self-induction of a circuit. He is told on p. 35, it is the ratio of the induced electromotive force in a circuit to the time-rate of change of the current producing it. He then learns on p. 50, that the practical unit is the Henry, which is 10^9 C.G.S. units. He then discovers that the C.G.S. unit of inductance is one centimetre, and he is left to imagine how a ratio can be measured in centimetres. This method of defining inductance is much more artificial than that which is based on notions of the energy associated with a current. The general properties of simple harmonic currents flowing in inductive circuits are then given, the arrangement and selection of the matter following closely on the lines of other existing English treatises on the same subject.

The body of the book is occupied with the treatment of the theory of the transformer. The author apparently takes the transformer chiefly to be an air-core transformer, with constant coefficients of self and mutual induction, and expends an immense amount of pains in solving various problems about this imaginary instrument, elaborately worked out with polar diagrams and a lavish use of algebra.

The results, however, when done have very little real use. Probably no transformer-maker that ever lived had occasion to measure a coefficient of self-induction, and the merest tyro ought to be told at the beginning of the subject that this method of approaching its treatment with the assumption of constant coefficients of inductance is but little use in connection with the actual iron-core transformer of real life. The theory of the transformer would be simplicity itself if the cyclic value of the induction created in an iron-core transformer by a periodic magnetising force could be simply expressed as a function of the force. In our ignorance of what really goes on inside iron when magnetised, all we are able to do at present is to express the area of the hysteresis curve in terms of its maximum ordinate, and no practical progress is made by raising a whirlwind of mathematical symbols around suppositions or premises not based on experience.

The chapters on alternate current curve tracing, transformer design, and testing, bring us more within touch of practice; but they are handled in a somewhat limited way. The curve tracing is chiefly restricted to the now almost obsolete hedgehog transformer, and the one instance in which the design for a transformer is worked out in complete detail is not confirmed by actual tests of the transformer so supposed to be made. These matters ought really to have formed the bulk of the book.

The good design of a transformer, like that of many other appliances, is largely a matter of compromise and experience. Full and exact details of actual transformers built, and the tests of the same, would have given useful information. As it stands, there is little or nothing which would be the least use in the drawing-office. A student asked to design an impedance coil to pass a current of fifteen amperes, and drop a pressure of sixty-five volts, would find no information in this volume to enable him to attack this simple problem with ease and certainty.

The fact is, that there are two ways of discussing a subject such as that of the treatise before us. One way is to collect all possible data from experiments and practice, and then develop from these a physical theory which shall reconcile all the facts, and be a sufficient guide to future practice. The other is to eliminate the real difficulties by assumptions akin to that of the frictionless pulley of applied mathematical text-books, and then evolve by sheer force of deductive reasoning all possible mathematical consequences. The latter method reduces

the subject to mere exercises in algebra and geometry; the former is the only process for advancing true knowledge. It is unfortunately the mathematician's transformer that figures so largely in the present volume. The subject of iron testing, the magnetic qualities of iron, its selection, and the effects of use on it for transformer cores, though fundamental matters of principle in the case of the real transformer, are not so much as mentioned, in spite of all that has been lately done in this matter. The avoidance of eddy current losses in the copper circuits and frames, the effect of magnetic leakage in causing such copper eddy current losses, the processes of ventilating large transformers, and the real difficulties of insulation, and the specialities of design for various purposes, are not named. The practical man, looking for approved principles of design in the case of the transformer, asks for the bread of practical experience; he is here presented with the stones of an artificial theory.

OUR BOOK SHELF.

Mechanics for Beginners. By Linnæus Cumming, M.A. Pp. viii + 247. (London: Rivington, Percival, and Co., 1896.)

Twenty years ago a Committee of the British Association recommended that the school teaching of physics should begin with a course of elementary mechanics, treated from an experimental point of view, and the opinion expressed in the Physics Section of the Association this year was in support of that view. Mr. Cumming has for some years been endeavouring to act upon the recommendation in the science classes of Rugby School, and the present book contains the course which his experience has proved to be the most suitable for beginners.

The book does not begin with dynamics, for though Mr. Cumming recognises the scientific advantages which this subject offers to the study of mechanics, he has found it too abstract for young students. Statics lends itself to experimental treatment, and is able to appeal directly to the convictions and interests of boys beginning the study of science. The first part of the book is, therefore, devoted to this branch of the subject, dynamics being treated in the second part, and hydrostatics in the third.

Teachers and students who are familiar with the author's books on electricity and heat, will know the character of his work. The present volume is thoroughly practical, is very clearly illustrated, and will doubtless find its way into many schools. It shows how mechanics may be experimentally taught in schools, and the principles demonstrated with simple apparatus; it thus contains the elements of a sound scientific education.

We regret to note the absence of an index, for no text-book is complete without one.

Hints on Elementary Physiology. By Florence A. Haig-Brown. Pp. xii + 121; 20 illustrations. (London: J. and A. Churchill, 1896.)

These "Hints" are based upon notes taken by the authoress and her sister while attending lectures and demonstrations given to probationers at St. Thomas's Hospital. They will be found helpful as a means of giving a general idea of the functions of the various parts of our bodies; and nurses who read them will acquire knowledge which will lead to the intelligent performance of duties.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

The Utility of Specific Characters.

I am anxious to avoid prolonging this discussion, but I should like to say a word in answer to Prof. Pearson and Mr. Cunningham. The letters of these gentlemen may lead some readers to infer that I have only just recognised the hypothetical nature of the law of growth of crabs assumed in the report of last year, to which reference has been made. I wish, therefore, to point out that the hypothetical nature of this assumption is recognised in the report itself (*Roy. Soc. Proc.*, vol. lvii. pp. 367–368), and in the remarks which accompany it (*ibid.*, pp. 381–382).

So far as I remember, this point was dwelt upon by at least one speaker in the discussion which followed the reading of the report: and the fact that I have spent the whole of my spare time, since the report was read, in an endeavour to ascertain the actual law of growth, is evidence that I have not been blind to its importance.

I must ask Prof. Pearson's leave to postpone a discussion of the actual law of growth until I have worked out the results of all my observations.

As for Prof. Pearson's second point—that correlations may arise by chance—I altogether fail to follow him; and the data which he gives concerning his hypothetical breed of cows, do not seem to me sufficient to serve as the basis of further discussion. W. F. R. Weldon.

University College, London, October 3.

An Error Corrected.

We regret to have to acknowledge a mistake which we have made in a communication to the Paris Académie des Sciences, reproduced in Nature of Aug. 27. It refers to the densities of helium; it does not affect the experimental results, nor the conclusion that helium has been split into two portions of unequal density; but it affects the figures assigned to these densities. The hypothetical case was stated that a mixture of four volumes of oxygen and one volume of hydrogen would diffuse in equal times, and *therefore could not be separated.* This conclusion is of course wholly wrong, and likewise in consequence the densities calculated for helium on a similar supposition. The densities of the two fractions of helium are therefore those found experimentally, viz. 1·874 and 2·133. It is right to observe that these figures stand for densities calculated from the observed rates of diffusion, and not from direct weighings

William Ramsay.
J. Norman Collie.

University College, London, October 1.

The Departure of the Swallows.

I do not know whether the eccentric behaviour of the swallows this year is of sufficient interest to justify me in troubling you with a letter. I am not the only person in this part of the world whose attention it has attracted.

Everybody is familiar with the spectacle of large assemblages of swallows immediately preceding their total disappearance; usually, I think, in early October. This year great multitudes were assembled here on September 1; both flying about this house, and at perch on rails and telegraph wires. On the two next days only one or two were visible, and on the two days succeeding none at all. I concluded that they had antedated their departure by a month, although in this locality the steady sunshine and dryness had not then ceased; but on Sept. 6 large numbers appeared, to disappear again the next morning. Since then their action, or the action of *some* swallows, has varied nearly in accordance with the twelve days' account which is appended. Yesterday (September 30) none were visible, nor are any to-day. But there has been no large assemblage immediately previous.

If you pay any attention at all to these remarks, please to

take them with many grains of salt. My observations have not been quite regular, and are wholly unscientific, and are confined to a very narrow area. In fact I cannot distinguish between a swallow and a martin when in flight, nor do I know what may be their differences in the affair of migration. I believe both kinds of swallow (to use the popular term) abound here in normal quantities, and I am told that swifts are comparatively scarce. But my own observation is of the shallowest and loosest character, confined indeed to the æsthetic side—viz. to admiration of the beauty and grace of the birds in dancing their endless reels.

Tuesday, September	1	...	multitudes of swallows.
Wednesday ,,	2	...	one or, perhaps, two.
Thursday ,,	3	...	
Friday ,,	4	...	none at all.
Saturday ,,	5	...	
Sunday ,,	6	...	multitudes.
Monday ,,	7	...	none (reappeared at 3 p.m. in small numbers).
Tuesday ,,	8	...	a few.
Wednesday ,,	9	...	none in morning; some about 2 p.m.
Thursday ,,	10	...	none observable.
Friday ,,	11	...	none observable.
Saturday ,,	12	...	a few.

After this, the quantities were about normal: not remarkable for multitudes or for paucity. HOBHOUSE.

Charlton House, Portbury, Bristol.

"The Scenery of Switzerland."

BEING away from home, I have only just seen NATURE of September 10, and I should like, with your permission, to make a few remarks on one or two points in Miss Ogilvie's review of my "Scenery of Switzerland."

With reference to the origin of transverse valleys, she says that I first describe them as due to erosion, and afterwards endeavour to explain them as the result of tectonic causes. I fear, therefore, that I have not made my meaning clear.

Some transverse valleys are no doubt entirely valleys of erosion, but in others the original direction is clearly the result of tectonic causes, though the depth may be due to erosion.

Miss Ogilvie goes on to remark that the idea that both longitudinal and transverse valleys "had their primal cause in tectonic movements, by no means finds its first exponent in Sir John Lubbock. It is perfectly familiar throughout the writings of Austrian and German geologists," and she gently blames me for not referring to them. But I made no such claim. Moreover, I quoted Prof. Bonney's interesting remarks on the fact. My suggested explanation is, however, quite different from that of the authors referred to by Miss Ogilvie. Their view was, in her own words, "that the transverse lines of weakness were planes of movement long after the longitudinal folds had ceased to move." My suggestion is, on the contrary, that transverse and longitudinal folds were simultaneous, and due to the same cause.

There is one other criticism on which I should like to say a few words.

Miss Ogilvie observes that "it is the greatest blemish in Sir John Lubbock's book that he nowhere gives a geological insight into the structure of the Monte Rosa massif of mountains from the Simplon Pass to the St. Bernard."

This difficult district was mapped by Gerlach, who was unfortunately killed by an accident before he had completed the letterpress.

No doubt there are several important memoirs on it, which I have read with interest. I had also the advantage of visiting it with Prof. Renevier and Prof. Golliez, and had, in fact, written several pages on the subject.

Certain of the rocks are, however, of such doubtful age, and there is so much difference of opinion, that the time has not yet, I think, arrived when a "geological insight" into this district can be given with confidence.

Under the circumstances, therefore, while regretting the omission, I thought it better not to make the attempt.

St. Andrews, September 21. JOHN LUBBOCK.

THE LIVERPOOL MEETING OF THE BRITISH ASSOCIATION.

VI.—THE EXCURSION TO THE ISLE OF MAN.

A SCIENTIFIC account of the Isle of Man was given as an appendix to the Liverpool "Handbook." This five days' excursion to the island may almost be regarded as a supplementary meeting of the Association. About a hundred members, representative of the more or less Biological Sections C, D, H, and K, left Liverpool on Thursday morning by the *Prince of Wales*, one of the best boats of the Isle of Man Steam Packet Company, and made a rapid passage to Douglas. There they were met on arrival by His Honour Deemster Gill and other leading members of the Natural History Society, and were conveyed to Government House, where His Excellency Lord Henniker gave a reception to the party. Later in the afternoon the Zoologists and Botanists went by train to their headquarters at Port Erin, while the Geologists and Archæologists settled down at Douglas.

The weather throughout has been rather tempestuous and unsettled, and has interfered to some extent with field work. Probably the Zoologists have suffered more than the other Sections, as they have been prevented from carrying out their proposed dredging expeditions. However the storms which rendered work at sea impossible made the shore-collecting more interesting, as vast quantities of *Laminaria* and others of the larger Algæ were cast up, with many animals attached or clinging to them.

The Zoological party included, in addition to the leaders (Prof. Herdman and Mr. Thompson), Prof. Poulton (Oxford), Dr. Hjort (Christiania), Dr. de Man (Holland), Dr. Gilchrist (Cape Town), and others. Both Zoologists and Botanists made considerable use of the Marine Biological Station at Port Erin for the examination and preservation of their specimens. On the Saturday, the Governor of the Island lunched with the party at Port Erin, and afterwards visited the Biological Station. The Botanists were largely engaged in marine work along with the Zoologists, but they also made several excursions into the glens and hills in search of mosses and other land plants. Amongst the more distinguished Botanists in the party were Profs. Weiss, Magnus, Pfitzer, Zacharias, and Chodat. All of them, as well as the foreign Zoologists, expressed themselves as deeply interested in the rich marine fauna and flora at Port Erin, and several made large collections.

The Archæological party was under the leadership of Mr. P. M. C. Kermode and Prof. Haddon. Their programme was carefully arranged so as to include examples of nearly every object of antiquarian interest in the island, and, being practically independent of weather, was completely carried out.

Prof. Haddon reports as follows on the work of this Section of the party:—"On the first day a visit was paid to the church of Braddan, with its interesting Scandinavian and Celtic crosses; and the obscure alignments were inspected. At the Tynwald Hill, near Peel, Deemster Gill gave an account of the promulgation of the laws; the afternoon was spent at Peel Castle, examining the ruins. On Saturday forenoon the Attorney-General took the party round Rushen Castle and its small but interesting museum of Manx antiquities, and in the afternoon Dr. Herdman's Biological Station was visited, and the unique Neolithic grave circle, explored a few years ago by Kermode and Herdman, was carefully inspected, and the probable age and history were discussed by Dr. Montelius, Dr. Munro, and others. The party went to Ramsey on Monday, and on the way ascended the ancient hill fort of Cronk Sumark. At Ramsey, as elsewhere, local collections were exhibited, and the splendid series of casts of early crosses, got together by the enthusiasm of Mr. P. M. C. Kermode, was greatly appreciated; so much was

this the case that, in recognition of his services to the study of archæology in the island and of his untiring energy and good nature as an organiser of the excursion, a number of the members of the party collected a contribution towards the expenses of completing this fine series of Manx crosses. The Archæological party was greatly delighted with all the arrangements that had been made for their comfort, and for the facilities that were offered for seeing the wonderfully interesting archæological remains in Man; while the presence of the distinguished Swedish Archæologist, Dr. Montelius, with his genial courtesy and unrivalled knowledge of prehistoric archæology, added greatly to the enjoyment of the excursion."

The leaders of the Geological party were Prof. Boyd Dawkins and Mr. G. W. Lamplugh, of the Geological Survey. Friday was devoted to the investigation of the southern part of the island, including the carboniferous limestone rocks of the Castletown district, the contemporaneous volcanic series of the Stack of Scarlet, the carboniferous conglomerates of Langness, the striking unconformability at their base, and the underlying Skiddaw series. The following day, Saturday, was spent on the northern portion of the Skiddaw "massif," and included the ascent (by electric railway) of Snaefell; the investigation of the curiously partial metamorphism of the slates on that mountain, and of the sections in Sulby Glen, which reveal the breaking up of the bedding and the production of the "crush-conglomerates" described recently by Lamplugh and Watts. On Monday the centre and west of the island were visited, and the sandstones of disputed age at Peel were examined. Stops were made *en route* at Crosby and Rockmount, to see the igneous rocks of different type intrusive into the Skiddaw series at these places. On the return journey the extensive lead mines at Foxdale were visited, and also the granite boss cropping out in that neighbourhood.

On the last evening of the excursion all the parties—Archæological, Geological, Zoological and Botanical—united in a final banquet at Douglas, when they entertained the Governor (Lord Henniker) and some of the leading officials of the island as guests. The company numbered about 120; Prof. Herdman presided, and amongst the seventeen speakers were—the Governor, the Attorney-General, Deemster Gill, the Mayor of Douglas, Profs. Boyd Dawkins, Poulton, Haddon and Pfitzer, Dr. Montelius and Dr. Munro. One subject specially brought forward in several of the speeches was the urgent need of a good museum of local natural history (in a wide sense) in the Isle of Man, and the suggestion was made that the museum might appropriately be erected as a memorial to the great Manx naturalist Edward Forbes.

The opinion seemed to be very generally expressed that this excursion stood out notably amongst British Association excursions, because of the relatively very large number of recognised investigators and authorities in their own branches of science who took part in it, and because of the solid scientific nature of the programme throughout the five days. And it may confidently be added that this "real work" aspect did not in the least detract from the thoroughly enjoyable character of the gathering. W. A. HERDMAN.

SIR JOHN ERIC ERICHSEN, BART., F.R.S.

SIR JOHN ERICHSEN, who died after a short illness on September 23, was born in 1818. So vigorous was he until the last in mind and body, that few would have suspected that this genial, kindly, and dignified gentleman had attained to the advanced age of seventy-eight. Essentially a practical surgeon, and devoted heart and soul to the advancement of surgery, he was a man of the widest sympathies, and in no way narrowed or restricted to a groove of professionalism. This may have been due in a measure to the early influence of Sharpey, who appears to have inspired the young surgeon with a keen interest in physiology, for we find his name in 1844 as Secretary to the Physiological Section of the British Association. He was also appointed about the same time to conduct an experimental investigation into the phenomena of asphyxia, which resulted in an important essay upon this subject, for which he received the Fothergillian medal of the Royal Humane Society. The claims of his profession soon, however, prevented Erichsen from further development in the direction of physiological science, and required his entire attention to be devoted to surgery. For already in 1850 he was appointed as the successor of Liston, Syme and Arnott, to the chair of Surgery in University College, and subsequently to the chair of Clinical Surgery; and one of these posts he continued to occupy during a quarter of a century. This was a brilliant period for operative surgery, although its brilliancy has been completely eclipsed in the quarter of a century which has succeeded it by the development of the Listerian method. Sir Joseph Lister was himself at one time house surgeon to Erichsen, and is one only, although no doubt the most distinguished, of many eminent surgeons who have left and are leaving their mark upon the scientific progress of their profession, and who owe much for their training to Sharpey and Erichsen.

Erichsen's "Science and Art of Surgery" is a classical work which appeared in 1853, and at once established the already won reputation of its author as one of the first surgeons of the day. It has run through many editions and been translated into most European languages, and, under the editorship of the late Marcus Beck and of Mr. Raymond Johnson, it is still in 1896 regarded as the best exposition of general surgery that we possess. Than this book no better proof could be forthcoming of the remarkable literary, scientific, and surgical attainments of its distinguished author!

Erichsen became President of the Royal Medical and Chirurgical Society in 1879, and of the Royal College of Surgeons in 1880, and in 1881 he was chosen to preside over the Surgical Section of the meeting of the International Medical Congress in London. He served on the Royal Commission on Vivisection, and was the first Inspector for England under the Act which resulted from the report of that Commission. In 1885 he stood for Parliament, on the Liberal side, for the Universities of Edinburgh and St. Andrews, but was unsuccessful. In 1887 his *alma mater* elected him President of its Council, an honourable post in which he was the successor of Brougham, Grote, Belper and Kimberley, and which he held until his death. The tact and urbanity which he displayed, and the quiet dignity with which he presided over its meetings, and over public meetings at University College during his presidentship, will be remembered by all who have taken part in them of late years. In 1895 he was, somewhat tardily, created a Baronet, at the same time as his life-long friend Russell Reynolds, whom he has only survived a few months. Within so short a time of his death it is not easy to speak calmly of the esteem and affection with which Sir John Erichsen was regarded by all who came under his influence. He was the most judicious of advisers, honourable and straightforward in all his dealings: a thorough gentleman. One of the most pleasing traits in his character was his uniform readiness to assist and encourage younger men in their pursuit of knowledge and in the practice of their profession. Needless to say that he was popular; it would have been difficult for the most cantankerous of mortals to remain unsubdued by his uniform kindness and generosity. Erichsen's death leaves a gap which it will be difficult to fill, and a reputation such as any man may envy. E. A. SCHÄFER.

NOTES.

The Council of the British Medical Association are prepared to receive applications for one of the three Research Scholarships which is vacant, of the value of £150 per annum, tenable for one year, and subject to renewal by the Council for another year. Applications should be sent to the General Secretary on or before Saturday, October 10, stating the particulars of the intended research, qualifications, and work done.

Following the usual custom, the winter session was commenced on Thursday last, in many of the medical schools in London and the provinces, by the delivery of addresses to the students. At Middlesex Hospital, Dr. W. Essex Wynter alluded to the rapid multiplication of books in modern times, and to the tendency that existed to go to them for information which should be gained at first hand, by direct observation. He described ideas gained from mere verbal accounts as artificial and spurious, and suggested that books should be used to complete and coordinate knowledge previously obtained by practical work. Prof. Sidney Martin inspired the students at University College Medical School with the spirit of investigation by giving a sketch of the advantages which medicine has obtained from the study of bacteriology. He pointed out that development of the experimental method has greatly aided the progress of medical science, and has been the means of improving the treatment of disease. It cannot be too strongly stated that the more that is known of the prime causes of disease, the more is it likely that measures will be discovered to prevent or counteract them. Mr. Morton Smale, at St. Mary's Hospital, dealt largely with quack medicines; and Mr. W. Adams Frost, at St. George's Hospital, discoursed chiefly upon medicine as a career. In the course of his address he referred to the appointment of the Royal Commission on vaccination, and said that, to people knowing the facts, it seemed about as reasonable to appoint a Commission to inquire into the truth of the law of gravitation. The introductory address at Westminster Hospital was given by Dr Wills, who took for his subject medical practice and practitioners as depicted in the literature of the last two centuries. Mr. Boyce Barrow discoursed upon some of the endowments of the human body, at the London School of Medicine for Women; Sir Henry Littlejohn addressed the students at Sheffield Medical School, on the advantages of a provincial medical school; while Mr. Victor Horsley urged upon the students at the Leeds Medical School the fundamental importance of chemistry in medicine work in all its stages, and discussed matters of medical education, ethics, and politics. Mr. Jonathan Hutchinson delivered the introductory address at Owens College, Manchester, where he pleaded for a wide scope in medical education, and urged the reformation of the examinational system. These and many more were the points dwelt upon at the various medical schools; and if the students pay regard to but a tithe of the advice given them, a high standard of professional ethics will be secured, and future practitioners will abundantly add to the knowledge of the causes of disease and the means of prevention.

We regret to record the death of Mr. W. C. Winlock, known for his contributions to astronomy. Mr. Winlock was assistant in charge of the office of the Smithsonian Institution. The death is also announced of Dr. J. P. E. Liesgang, a voluminous writer on photographic matters, and the founder of the *Photographische Archiv*; and of Dr. J. A. Moloney, who took a prominent part in the Stairs expedition to Katanga.

Lord Selborne took the chair at a meeting, held on Tuesday, to discuss the establishment of an International Submarine Telegraph Memorial. It is proposed to connect the memorial especially with the names of Mr. Cyrus Field, Sir John Pender, and Sir James Anderson. An executive committee was appointed to consider the form which the memorial shall take.

The South African Museum has recently received a fine mounted specimen of the white or square-mouthed Rhinoceros (*Rhinoceros simus*) which was shot in the Mazoe district of Mashonaland, in June last year, by Mr. A. Eyre. The skin and skeleton were purchased by Mr. C. J. Rhodes, and, after having been sent to England to be set up, were presented by him to the South African Museum.

The motor-car race from Paris to Marseilles and back, a total distance of 1051 miles, was finished on Saturday last. Twenty-seven of the vehicles which started from Paris on Thursday, September 24, were petroleum carriages, and five were tricycles driven by petroleum motors. There were also four steam carriages. The race was organised by the Automobile Club of France, and was intended entirely as a test of speed. On each day of the ten days the times occupied by the carriages in covering the several stages have been taken, and the winner is the car which travelled the whole distance in the least time. Details of the race have not yet come to hand, but owing to bad roads and obstructions by trees and telegraph-poles blown down by the gale which prevailed early in the contest, the journey was not accomplished under the best conditions.

The first number has been issued, on September 1, of a new natural history periodical, *Il Naturalista Siciliano*, the organ of the newly-formed Society of Sicilian Naturalists, of which Prof. E. Ragusa is the president, and Sig. T. De Stefani the secretary. The Society is intended to meet monthly in Palermo, and once a year in some other city of Sicily. The first number contains articles, in Italian and in French, on Entomology, Malacology, Botany, and Crustacea. The proposed biological station at Palermo, mentioned in our last number, will be under the management of the Society.

An interesting note on the influence of the male parent in crossing varieties of carnations, appears in the current number (August) of the *Journal* of the Royal Horticultural Society. Evidence in favour of this prepotency is afforded by experiments, carried out by Mr. Martin Smith, on the fertilisation of "Germania." This is a flower of strong individuality, yet, says Mr. Smith, "Germania (yellow) is swamped by the prepotency of the pollen parent in the great majority of cases. I hardly ever get a yellow worth having; but when I do I find them, as a rule, pure reproductions on a most feeble scale of the mother; and I always regard them as products of Germania fertilised by pollen of flowers on the same plant, or from one in the immediate vicinity." On the other hand, when the pollen of Germania was used to fertilise other plants, extremely few yellow flowers resulted from the cross. It seems to be easy enough in a cross for other colours to overcome yellow, but difficult for yellow to be masterful. Mr. Smith adds the interesting fact that when he crossed violent contrasts of colour, such as purple and yellow, or scarlet and yellow, a large proportion of white flowers appeared among the offspring.

By common agreement the wasp is accepted as emblematical of irritability and petty malignity; but even this much-abused hymenopterous insect plays a beneficial part in the work of nature, as a note in the *Irish Naturalist* testifies. A number of wasps were seen by Mr. R. M. Barrington, of Bray, buzzing about his cows. Closer inspection revealed that they were all busy catching flies, and pouncing with the rapidity of hawks after birds on the flies as they tried to settle or rest on some favourite part of the cow. One white cow drew more wasps than any of the others, because the moment a fly alighted it was seen at once against the skin. When a wasp catches a fly it immediately

bites off both wings, sometimes a leg or two, and occasionally the head. Mr. Barrington saw some of the wasps when laden with one fly catch another, without letting go the first, and then fly away with both. There was a constant stream of wasps carrying away flies, probably to feed the larvæ in their nests, and returning again to the cows to catch more. In about twenty minutes Mr. Barrington estimated that between 300 and 400 flies were caught on two cows lying close to where he stood. Perhaps this narrative of good deeds accomplished will lead people to think more leniently of the vices of the wasp.

"ÜBER LUMINESCENZ" is the title of a small pamphlet of 60 pages (Univ. Buchdruckerei von Fr. Junge, Erlangen, 1896), which we have received from the author, Dr. Wilhelm Arnold. In its pages will be found the results of the investigation which the author has carried out with regard to luminescence phenomena, and this may be said to be continuous with the works done by Herren E. Wiedemann and G. C. Schmidt. Dr. Arnold has examined several inorganic bodies, solutions, and organic substances with regard to their different powers of luminescence, and has found a new series of bodies exhibiting this peculiarity excellently. The apparatus used for exciting the substances by means of the kathode rays was similar to that employed by the above-mentioned experimenters. While engaged in this work, Prof. Röntgen's discovery of the X-rays suggested to the author to make investigations on the behaviour of these rays on "feste Lösungen." These results are also brought together, and they deal, further, with the transparency of different substances to these rays, their power over bacteria, and the sensitiveness of the photographic plate. All those at work on this branch of physics will find this pamphlet an earnest endeavour to advance our knowledge in this particular direction; and its value is further increased by the numerous references which the author has inserted in the form of foot-notes.

FROM the St. Petersburg Municipal Laboratory comes an alarming report, by M. M. P. Sacharbekoff, of the milk supplied to the city. Dr. Bitter has endeavoured to establish a microbial standard for milk, by which the bacterial contents of a so-called good sample of milk are limited to 50,000 per cubic centimetre. If this standard is to be accepted, then it is time St. Petersburg looked into its milk supply, for M. Sacharbekoff finds that the maximum microbial contents in a cubic centimetre of its milk reaches no less than 115,300,000! For the sake of comparison the milk microbial maximum of other cities is cited, amongst which we find Munich figuring with 4,000,000 per c.c., Würzburg with 7,535,000, whilst Giessen even surpasses St. Petersburg with a maximum of 169,632,000. The samples of milk were also tested by means of direct inoculation into animals for the presence of pathogenic bacteria. No less than eighty guinea-pigs were used in these inoculations, out of which four succumbed to the tubercle bacillus, three to the staphylococcus *Pyogenes aureus*, two to *B. coli communis*, and five to other pathogenic microbes. But, besides these bacteria, various saprophytes were isolated out, which it was found were able to elaborate in the milk toxic products of a highly deleterious character. The high rate of mortality from diarrhœa, which prevails amongst young children in St. Petersburg up to five years of age, and which amounts to no less than 43 per cent., is, the writer considers, to a large extent attributable to the impure milk supplied to the city. The worst samples were obtained from the milk-women who buy the milk second-hand, and distribute it to their customers. M. Sacharbekoff ends his report by drawing up a number of suggestions, amongst which is advocated a closer control over the milk supply by competent sanitary authorities.

SOME of the results which the Norwegian traveller Sven Hedin has obtained in his journeys to the northern part of the Kwenlung mountains, and towards the east of the town of Khotan, are summed up in *Globus* (Band lxx., No. 13). It seems that between Kerija and Shahyar, Sven Hedin found the ruins of large towns which had been buried in sand, and his calculations suggest that they were entombed by successive sandstorms about 1000 years ago. The discoveries he made were, considering the difficulties to be contended with, extensive. One of the towns he found was over four kilometres long, and consisted of a great number of house ruins; the separate houses were not built of stone, but constructed of wooden pillars, and the walls consisted of plaited reeds covered with mud. These latter were coated with white plaster, on which were painted human figures, horses, dogs and flowers. Small figures, 10–20 cm. high, representing Budda, were also discovered, besides numerous poplars, apricot and plum trees, which once flourished there when the towns were watered by the canal from the river Kerija. It is suggested that the culture of the inhabitants must have been very considerable, for the copies of the drawings on the walls brought back by Sven Hedin show indications of good execution.

THE *Journal of Botany* gives an interesting account of Herr R. Schlechter's botanical explorations in South Africa, which have been much impeded by the drought. He has collected about 1200 species, of which he estimates at least one-tenth to be new.

ANOTHER of the useful "Hand-lists" issued from the Royal Gardens, Kew, has just been received. It is Part ii. of the list devoted to trees and shrubs grown in the Arboretum, and comprises *Gamopetalæ* to *Monocotyledons*.

A NEW edition (the fourth) of "The Microtomist's Vade Mecum," by Mr. A. B. Lee, has been published by Messrs. J. and A. Churchill. The work is a handbook of the methods of microscopic anatomy, and it constitutes a most complete account of the operations of histological technique. To all who are engaged in histological studies the volume is invaluable.

THE Society for the Protection of Birds is very enthusiastic in the prosecution of the good work it was founded to perform, and has already met with much encouragement in its labours. Its latest, but by no means least important, development is the commencement of a series of leaflets, entitled the "Educational Series," under the editorship of Mr. H. E. Dresser, which aims at supplying to the public, in a not too technical form, authoritative information respecting the seven following points:—Name [of bird], general description, where, when and in what numbers found, food, characteristics, protection, and remarks. The pioneers of the series are "Owls," by Mr. Montagu Sharpe, and "Woodpeckers," by Sir Herbert Maxwell, Bart. We wish for the publications and their successors a very wide circulation, as we feel sure their perusal will remove from the minds of many farmers, gamekeepers, and others, a great deal of misapprehension at present lurking there.

THE additions to the Zoological Society's Gardens during the past week include a Pig-tailed Monkey (*Macacus nemestrinus*) from Java, a Bonnet Monkey (*Macacus sinicus*) from India, presented by Mr. Edward Good; a Patas Monkey (*Cercopithecus patas*) from West Africa, presented by Mr. W. S. Gilbert; a Red-fronted Lemur (*Lemur rufifrons*) from Madagascar, a Serval (*Felis serval*), two Side-striped Jackals (*Canis lateralis*), a Pale Genet (*Genetta senegalensis*), a Vociferous Sea Eagle (*Haliaetus vocifer*), a —— Hawk (*Accipiter* sp.?) from British Central Africa, presented by Sir Harry Johnston, K.C.B.; a Black Francolin (*Francolinus vulgaris*) from the Syrian Coast,

presented by Admiral Sir M. Culme-Seymour, Bart., K.C.B.; a Kite (*Milvus ictinus*), British, presented by Mr. E. A. Wilson; a Hedgehog (*Erinaceus* sp. ?) from the Erkomit Hills, Eastern Soudan, presented by Mr. J. U. Coxen; a King Parrakeet (*Aprosmictus scapulatus*) from Australia, presented by Mrs. Lyons; three Chameleons (*Chamæleon vulgaris*) from North Africa, presented by Mr. E. Palmer; two Moorish Tortoises (*Testudo mauritanica*) from North Africa, presented by Mr. A. J. Aitchinson; two Black Tortoises (*Testudo carbonaria*) from Granada, W.I., presented by Mr. Thomas Ottway; seven Pratincoles (*Glareola pratincola*), European, deposited; a Levaillant's Amazon (*Chrysotis levaillanti*) from Mexico, a Yarrell's Curassow (*Crax carunculata*) from South-east Brazil, a long-tailed Glossy Starling (*Lamptornis æneus*) from West Africa, purchased; an Asiatic Wild Ass (*Equus onager*), a Great Kangaroo (*Macropus giganteus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET GIACOBINI.—Our previous ephemeris of this comet was inclusive up to October 1. A Centralstelle Circular gives us a continuation of this ephemeris, based on new elements (September 5, 8, 11) calculated by Dr. H. Kreutz.

1896.	R.A. h. m. s.	Decl. ° ′	log Δ	B.
Oct. ... 5·5 ...	18 22 35	−12 2·5	0·1651	0·9
9·5 ...	33 42	12 28·5	0·1706	0·9
13·5 ...	45 8	12 51·4	0·1764	0·9
17·5 ...	56 51	13 10·9	0·1826	0·9

COMET SPERRA.—With regard to the comet, information about which was communicated by a Science Observer Special Circular (No. 113), a Kiel Circular gives us an ephemeris which Prof. Lamp has calculated from new elements based on observations on September 6, 10, 13. Mr. Sperra describes this comet, as he observed it on August 31, as a nebulous object west of Zeta Ursa Major, an interval of an hour and a quarter showing distinct motion. Mr. Brooks, who had had notice of this discovery on September 4, also found the comet. Various new observed positions are given in *Astronomischen Nachrichten* (No. 3379) by several observers.

Prof. Lamp's ephemeris is given below :—

1896.	R.A. h. m. s.	Decl. ° ′	log Δ	B.
Oct. 6·5 ...	16 53 22 ...	+43 59·6 ...	0·2478 ..	0·6
10·5 ..	17 11 36 ...	41 44·7 ...	0·2569 ...	0·6
14·5 ...	17 28 24	39 29·0 ...	0·2671 ...	0·5
18·5 ...	17 43 56 ...	37 14·9 ...	0·2785 ...	0·5

PROF. LUDWIG PHILIPP V. SEIDEL.—The current number of *Astronomischen Nachrichten* contains a short obituary notice, by Prof. Seeliger, of Prof. v. Seidel, who died recently in Munich, after a long illness. He was born in the year 1821 at Zweibrücken, and studied in the universities of Königsberg, Berlin, and Göttingen, in which he attended the lectures of Bessel, Jacobi, Dirichlet and Gauss, with the two former of whom he became intimately acquainted. Seidel's scientific work was not only restricted to pure mathematics, but also to astronomy. In the former, his researches are well known, and of great importance is his "Note über eine Eigenschaft der Reihen, welche discontinuirliche Functionen darstellen," which contains a beautiful and important conception of regular and irregular convergence in the theory of series. He took no small part in Jacobi's well-known work on the secular perturbations of the major planets, in which he undertook the computations of extensive numerical results. Jacobi's proposal of obtaining by successive approximations the numerical solution of a system of normal equations of several unknowns, was further worked out in detail and extended by Seidel himself. No less interesting are the optical works Seidel completed in conjunction with Herrn C. A. Steinheil; among these may be mentioned his numerous dioptical investigations, which marked a distinct progress in this direction. These and other researches were of great importance in connection with Steinheil's photometric investigations.

THE BRITISH ASSOCIATION.

SECTION I.

PHYSIOLOGY.

OPENING ADDRESS BY W. H. GASKELL, M.D., LL.D., F.R.S., PRESIDENT OF THE SECTION.

WHEN I received the honour of an invitation to preside at the Physiological Section of the British Association, my thoughts naturally turned to the subject of the Presidential Address, and it seemed to me that the traditions of the British Association, as well as the fact that a Physiological Section was a comparatively new thing, both pointed to the choice of a subject of general biological interest rather than a special physiological topic; and I was the more encouraged to choose such a subject because I look upon the growing separation of physiology from morphology as a serious evil, and detrimental to both scientific subjects. I was further encouraged to do so by the thought that, after all, a large amount of the work done in physiological laboratories is anatomical—either minute anatomy or topographical anatomy, such as the tracing out of the course of nerve-fibre tracts in the central and peripheral nervous system by physiological methods. Such methods require to be supplemented by the morphological method of inquiry. If we can trace up step by step the increasing complexity of the vertebrate central nervous system; if we can unravel its complex nature, and determine the original simpler paths of its conducting fibres, and the original constitution of the special nerve centres, then it is clear that the method of comparative anatomy would be of immense assistance to the study of the physiology of the central nervous system of the higher vertebrates. So also with numbers of other physiological problems, such as, for instance, the question whether all muscular substances are supplied with inhibitory as well as motor nerves; to which is closely allied the question of the nature of the mechanism by which antagonistic muscles work harmoniously together. Such questions receive their explanation in the researches of Biedermann on the nerves of the opening and closing muscles of the claw of the crayfish, as soon as it has been shown that a genetic relationship exists between the nervous system and muscles of the crayfish and those of the vertebrate.

Take another question of great interest in the present day, viz. the function of such ductless glands as the thyroid and the pituitary glands. The explanation of such function must depend upon the original function of these glands, and cannot, therefore, be satisfactory until it has been shown by the study of comparative anatomy how these glands have arisen. The nature of the leucocytes of the blood and lymph spaces, the chemical problems involved in the assigning of cartilage into its proper group of mucin compounds, and a number of other questions of physiological chemistry, will all advance a step nearer solution as soon as we definitely know from what group of invertebrates the vertebrate has arisen.

I have therefore determined to choose as the subject of my address "The Origin of Vertebrates," feeling sure that the evidence which has appealed to me as a physiologist will be of interest to the Physiological Section; while at the same time, as I have invited also the Sections of Zoology and Anthropology to be present, I request that this address may be considered as opening a discussion on the subject of the origin of vertebrates. I do not desire to speak *ex cathedrâ*, and to suppress discussion, but, on the contrary, I desire to have the matter threshed out to its uttermost limit, so that if I am labouring under a delusion the nature of that delusion may be clearly pointed out to me.

The central pivot on which the whole of my theory turns is the central nervous system, especially the brain region. There is the *ego* of each animal; there is the master-organ, to which all the other parts of the body are subservient. It is to my mind inconceivable to imagine any upward evolution to be associated with a degradation of the brain portion of the nervous system. The striking factor of the ascent within the vertebrate phylum from the lowest fish to man is the steady increase of the size of the central nervous system, especially of the brain region. However much other parts may suffer change or degradation, the brain remains intact, steadily increasing in power and complexity. If we turn to the invertebrate kingdom, we find the same necessary law: when the metamorphosis of an insect takes place, when the larval organs are broken up by a process of histolysis, and new ones formed, the central nervous system remains essentially intact, and the

brain of the imago differs from that of the larva only in its increased growth and complexity.

A striking instance of the same necessary law is seen in the case of the transformation of the larval lamprey, or Ammocœtes, into the adult lamprey, or Petromyzon; here also, by a process of histolysis, most of the organs of the head region of the animal undergo dissolution and re-formation, while the brain remains intact, increasing in size by the addition of new elements, without any sign of preliminary dissolution. On the other hand, when, as is the case in the Tunicates, the transformation process is accompanied with a degradation of the central nervous system, we find the adult animal so hopelessly degraded that it is impossible to imagine any upward evolution from such a type.

It is to my mind perfectly clear that, in searching among the Invertebrata for the immediate ancestor of the Vertebrata, the most important condition which such ancestor must fulfil is to possess a central nervous system, the anterior part of which is closely comparable with the brain region of the lowest vertebrate. It is also clear on every principle of evolution that such hypothetical ancestor must resemble the lowest vertebrate much more closely than any of the higher vertebrates, and therefore a complete study of the lowest true vertebrate must give the best chance of discovering the homologous parts of the vertebrate and the invertebrate. For this purpose I have chosen for study the Ammocœtes, or larval form of the lamprey, rather than Amphioxus or the Tunicates, for several reasons.

In the first place, all the different organs and parts of the higher vertebrates can be traced directly into the corresponding parts of Petromyzon, and therefore of Ammocœtes. Thus, every part of the brain and organs of special sense—all the cranial nerves, the cranial skeleton, the muscular system, &c., of the higher vertebrates can all be traced directly into the corresponding parts of the lamprey. So direct a comparison cannot be made in the case of Amphioxus or the Tunicates.

Secondly, Petromyzon, together with its larval form, Ammocœtes, constitutes an ideal animal for the tracing of the vertebrate ancestry, in that in Ammocœtes we have the most favourable condition for such investigations, viz. a prolonged larval stage, followed by a metamorphosis, and the consequent production of the imago or Petromyzon—a transformation which does not, as in the case of the Tunicates, lead to a degenerate condition, but, on the contrary, leads to an animal of a distinctly higher vertebrate type than the Ammocœtes form. As we shall see, the Ammocœtes is so full of invertebrate characteristics that we can compare organ for organ, structure for structure, with the corresponding parts of Limulus and its allies. Then comes that marvellous transformation scene during which, by a process of histolysis, almost all the invertebrate characteristics are destroyed or changed, and there emerges a higher animal, the Petromyzon, which can now be compared organ for organ, structure for structure, with the larval form of the Amphibian; and so through the medium of these larval forms we can trace upwards without a break the evolution of the vertebrate from the ancient king-crab form. On the other hand, Amphioxus and the Tunicates are distinctly degenerate; it is easier to look upon either of them as a degenerate Ammocœte than as giving a clue to the ancestor of the Ammocœte. It is to my mind surprising how difficult it appears to be to get rid of preconceived opinions, for one still hears, in the assertion that Petromyzon as well as Amphioxus is degenerate, the echoes of the ancient myth that the Elasmobranchs are the lowest fishes, and the Cyclostomata their degenerated descendants.

The characteristic of the vertebrate central nervous system is its tubular character: and it is this very fact of its formation as a tube which has led to the disguising of its segmental character, and to the whole difficulty of connecting vertebrates with other groups of animals. The explanation of the tubular character of the central nervous system is the keystone to the whole of my theory of the origin of vertebrates. The explanation which I have given differs from all others, in that I consider the nervous system to be composed of two parts—an internal epithelial tube, surrounded to a greater or less extent by a segmented nervous system; and I explain the existence of these two parts by the hypothesis that the internal epithelial tube was originally the alimentary canal of an arthropod animal, such as Limulus or Eurypterus, which has become surrounded to a greater or less extent by the nervous system.

Any hypothesis which deals with the origin of one group of animals from another must satisfy three conditions:—

(1) It must be in accordance with the phylogenetic history of each group. It must therefore give a consistent explanation of all the organs and tissues of the higher group which can be clearly shown not to have originated within the group itself. At the same time, the variations which have occurred on the hypothesis must be in harmony with the direction of variation in the lower group, if not actually foreshadowed in that group.

This condition may be called the Phylogenetic test.

(2) The anatomical relation of parts must be the same in the two groups, not only with respect to coincidence of topographical arrangement, but also with respect to similarity of structure, and, to a large extent, also of function.

This condition may be called the Anatomical test.

(3) The peculiarities of the ontogeny or embryological development of the higher group must receive an adequate explanation by means of the hypothesis, while at the same time they must help to illustrate the truth of the hypothesis.

This condition may be called the Ontogenetic test.

I hope to convince you that all these three conditions are satisfied by my hypothesis as far as the head region of the vertebrate is concerned. I speak only of the head region at present, because that is the part which I have especially studied up to the present time, and also because it is natural and convenient to consider the cranial and spinal nerves separately; and I hope to demonstrate to you that not only the nervous system and alimentary canal of such a group of animals as the Gigantostraca—*i.e.* Limulus and its allied forms—is to be found in the head region of Ammocœtes, but also, as must logically follow, that every part of the head region of Ammocœtes has its homologous part in the prosomatic and mesosomatic regions of Limulus and its allies. I hope to convince you that our brain is hollow because it has grown round the old cephalic stomach: that our skeleton arose from the modifications of chitinous ingrowths; that the nerves of the medulla oblongata—*i.e.* the facial, glosso-pharyngeal, and vagus nerves—arose from the mesosomatic nerves to the branchial and opercular appendages of Limulus, while the nerves of the hind brain are derived from the nerves of the prosomatic region of Limulus; that our cerebral hemispheres are but modifications of the supra-œsophageal ganglia of a scorpion, while our eyes and nose are the direct descendants of its eyes and olfactory organs.

In the first place, I will give you shortly the reasons why the central nervous system of the vertebrate must be considered as derived from the conjoined central nervous system and alimentary canal of an arthropod.

Comparison of the Central Nervous System of Ammocœtes with the Conjoined Central Nervous System and Alimentary Canal of an Arthropod Animal such as Limulus.

1. *The phylogenetic test* proves that the tube of the central nervous system was originally an epithelial tube, surrounded to a certain extent by nervous material.

The anatomical test then proves that this epithelial tube corresponds in its topographical relations to the nervous material exactly with the alimentary canal of an arthropod in its relations to the central nervous system; and, further, that the topographical relations, structure, and function of the corresponding parts of this nervous material are identical in the Ammocœtes and in the arthropod.

We see from these diagrams, taken from Edinger, how the greater simplicity of the brain region as we descend the vertebrate phylum is attained by the reduction of the nervous material more and more to the ventral side of the central tube, with the result that the dorsal side becomes more and more epithelial, until at last, as is seen in Ammocœtes, the roof of the epichordal portion of the brain consists entirely of fold upon fold of a simple epithelial membrane, interrupted only in one place by the crossing of the IVth nerve and commencement of the cerebellum. In the prechordal part of the brain this simple epithelial portion of the tube is continued on in the middle line as the first choroid plexus of Ahlborn, and the lamina terminalis round to the ventral side; where, again, in the infundibular region, the epithelial saccus vasculosus, which has been becoming more and more conspicuous in the lower vertebrates, together with the median tube of the infundibulum, testifies to the withdrawal of the nervous material from this part of the brain, as well as from the dorsal region. Further, as already mentioned in my previous papers, the invasion of this epithelial tube by nervous material during the upward development of the vertebrate is beautifully shown by the commencing development of the cerebellar hemi-

spheres in the dogfish; by the dorsal growth of nervous material to form the optic lobes in the Petromyzon; by the occlusion of the ventral part of the tube in the epichordal region to form the raphé, as seen in its commencement in Ammocœtes. Finally, evidence of another kind in favour of the tubular formation being

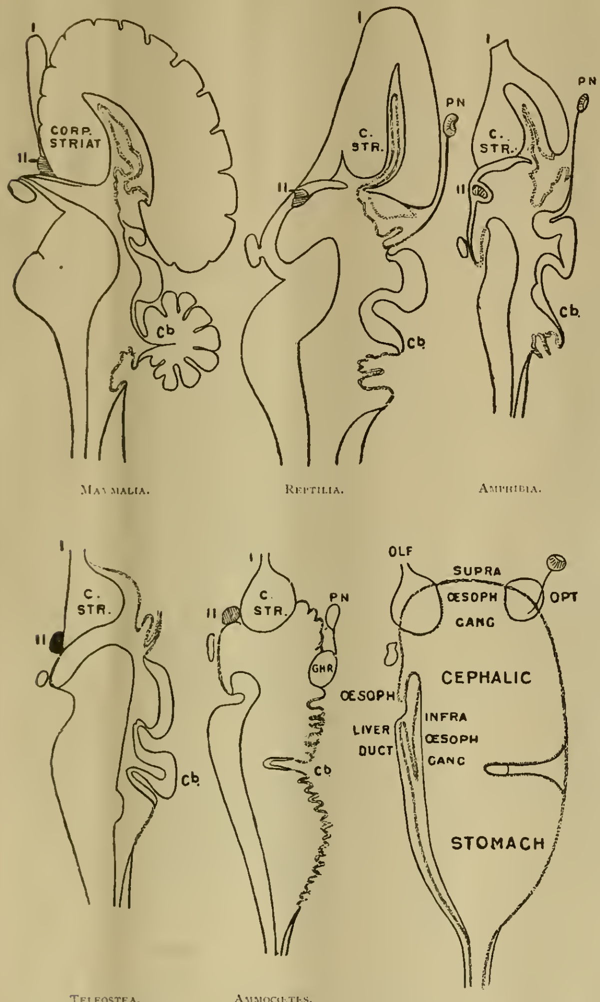


FIG. 1.—Comparison of Vertebrate Brain from Mammalia to Ammocœtes. (Epithelial parts represented by dotted lines.)

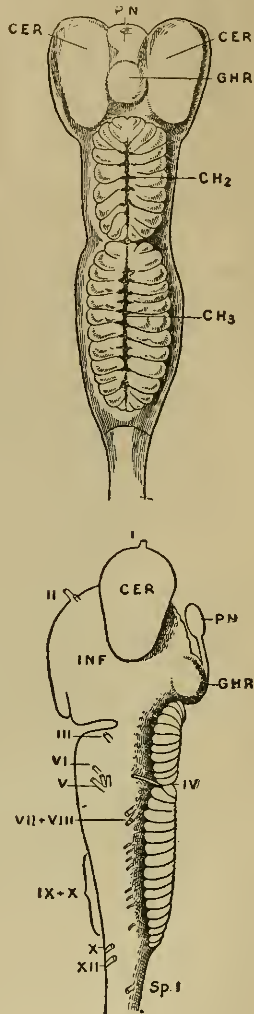


FIG. 2.—Dorsal and lateral view of the Brain of Ammocœtes.

due to an original non-nervous epithelial tube, is given by the frequent occurrence of cystic tumours, and also by the formation of the sinus rhomboidalis in birds.

The phylogenetic history of the brain of vertebrates, in fact, is in complete harmony with the theory that the tubular nervous system of the vertebrate originally consisted of two parts—viz. an epithelial tube and a nervous system outside that tube, which has grown over it more and more, and gives not only no support whatever, but is in direct opposition, to the view that the whole tube was originally nervous, and that the epithelial portions, such as the choroid plexuses and roof of the fourth ventricle, are thinned-down portions of that nerve tube. Passing now to

2. *The anatomical test*, we see immediately why this epithelial tube comes out so much more prominently in the lowest vertebrates, for, as can be seen from the diagrams, and is more fully

pointed out in my previous papers,[1] every part of the central tube of the vertebrate nervous system corresponds absolutely, both in position and structure, with the corresponding part of the alimentary canal of the arthropod, and the nervous material which is arranged round this epithelial tube is identically the same in topographical position, in structure, and in function as the corresponding parts of the central nervous system of an arthropod.

Especially noteworthy is it to find that the pineal eye (PN), with its large optic ganglion, the ganglion habenulæ (GHR), falls into its right and appropriate place as the right median eye of such an animal as Limulus or Eurypterus. In the following table I will shortly group together the evidence of the anatomical test.

A. *Coincidence of Topographical Position.*

LIMULUS AND ITS ALLIES.	AMMOCŒTES AND VERTEBRATES.
Alimentary Canal:—	
1. Cephalic stomach.	Ventricles of the brain.
2. Straight intestine, ending in anus.	Spinal canal, ending by means of the neurenteric canal in the anus
3. Œsophageal tube.	Median infundibular tube and saccus vasculosus.
Nervous System:—	
1. Supra-œsophageal ganglia.	Brain proper, or cerebral hemispheres.
2. Olfactory ganglia.	Olfactory lobe.
3. Optic ganglia of the lateral eyes.	Optic ganglia of the lateral eyes.
4. Optic ganglia of the median eyes.	Ganglia habenulæ.
5. Median eyes.	Pineal eyes.
6. Œsophageal commissures.	Crura cerebri.
7. Infra-œsophageal or prosomatic ganglia giving origin to the prosomatic nerves.	Hind brain, giving origin to the IIIrd, IVth, and Vth cranial nerves.
8. Mesosomatic ganglia, giving origin to the mesosomatic nerves.	Medulla oblongata, giving origin to the VIIth, IXth, and Xth cranial nerves.
9. Metasomatic ganglia.	Spinal cord.

B. *Coincidence of Structure and Physiological Function.*

(1) The simple non-glandular epithelium of the nerve tube coincides with the simple non-glandular epithelium of the alimentary canal, ciliated as it is in Daphnia (Hardy and McDougall, *Proc. Camb. Philos. Soc.*, vol. viii., 1893).

(2) The structure and function of the cerebral hemispheres, olfactory lobes, and optic ganglia closely resemble the corresponding parts of the supra-œsophageal ganglia.

(3) The structure of the right pineal eye, with its nerve end-cells and rhabdites, is of the same nature as that of a median arthropod eye.

(4) The structure of the right ganglion habenulæ is the same as that of the optic ganglion of the median eye.

(5) The region of the hind brain, like the region of the infra-œsophageal ganglia, is concerned with the co-ordination of movements.

(6) The region of the medulla oblongata, like the mesosomatic region of Limulus and its allies, is concerned especially with the movements of respiration.

(7) The centres for the segmental cranial nerves resemble closely in their groups of motor cells and plexus substance the centres for the prosomatic and mesosomatic nerves, with their groups of motor cells and reticulated substance (Punkt-Substanz).

3. *The third test is the ontogenetic test.* The theory must be in harmony with, and be illustrated by, the embryonic development of the central nervous system. Such is the case, for we see that the nerve tube arises as a simple straight tube opening by the neurenteric canal into the anus, the anterior part of the tube, *i.e.* the cephalic stomach region, being remarkably dilated; the anterior opening of this tube, or anterior neuropore, is considered by most authors to have been situated in the infundibular region.

Next comes the formation of the cerebral vesicles, indicating embryologically the constricting growth of nervous material outside the cephalic stomach. First, the formation of two cerebral vesicles by the growth of nervous material in the position of the ganglia habenulæ, posterior commissure, and Meynert's bundle, *i.e.* the constricting influence of commissures between the optic part of the supra-œsophageal ganglia and the infra-œsophageal ganglia; then the formation of the third cerebral vesicle by the constricting influence of the IVth nerve and commencing cerebellum. Subsequently the first cerebral vesicle is divided into two parts by another nerve commissure—the anterior commissure, *i.e.* by nerve material joining the supra-œsophageal ganglia. Further, the embryological evidence shows that in the spinal cord region the nerve masses are at first most conspicuous ventrally and laterally to the original tube, such ventral masses being early connected together with the strands of the anterior commissure; ultimately, by the growth of nervous material dorsalwards, the dorsal portion of the tube is compressed to form the posterior fissure and the substantia Rolandi, the original large lumen of the old intestine being thus reduced to the small central canal of the adult nervous system. Finally, this nerve tube is formed at a remarkably early stage, just as ought to be the case if it represented an ancient alimentary canal.

The ontogenetic test appears to fail in two points:—

(1) That the nerve tube of vertebrates is an epiblastic tube, whereas if it represented the old invertebrate gut it ought to be largely hypoblastic.

(2) The nerve tube of vertebrates is formed from the dorsal surface of the embryo, while the central nervous system of arthropods is formed from the ventral surface.

With respect to the first objection, it might be argued, with a good deal of plausibility, that the term hypoblast is used to denote that surface which is known by its later development to form the alimentary canal; that in fact, as Heymons ("Die Embryonalentwickl. v. Dermapteren u. Orthopteren," Jena, 1895) has pointed out, the theory of the germinal layers is not sufficiently well established to give it any phylogenetic value. It is, however, unnecessary to discuss this question, seeing that Heymons has shown that the whole alimentary tract in such arthropods as the earwig, cockroach, and mole cricket, is, like the nerve tube of vertebrates, formed from epiblast.

The second objection appears to me more apparent than real. The nerve layer in the vertebrate, as soon as it can be distinguished, is always found to lie ventrally to the layer of epiblast which forms the central canal. In the middle line of the body, owing to the absence of the mesoblast layer, the cells which form the notochord and those which form the central nervous system form a mass of cells which cannot be separated in the earlier stages. The nerve layer in the arthropod lies between the ventral epiblast and the gut; the nerve layer in the vertebrate lies between the so-called hypoblast (*i.e.* the ventral epiblast of the arthropod) and the neural canal (*i.e.* the old gut of the arthropod). The new ventral surface of the vertebrate in the head region is not formed until the head fold is completed. Before this time, when we watch the vertebrate embryo lying on the yolk, with its nervous system, central canal, and lateral plates of mesoblast, we are watching the embryonic representation of the original Limulus-like animal; then, when the lateral plates of mesoblast have grown round, and met in the middle line to assist in forming the new ventral surface, and the head fold is completed, we are watching the embryonic representation of the transformation of the Limulus-like animal into the scorpion-like ancestor of the vertebrates.

In the Arthropoda, the simple epithelial tube which forms the stomach and intestine is not a glandular organ, and we find that the digestive part of the alimentary tract is found in the large organ, the so-called liver. This organ, together with the generative glands, forms an enormous mass of glandular substance, which, in Limulus, is tightly packed round the whole of the central nervous system and alimentary canal, along the whole length of the animal (represented in Fig. 4 by the dark dotted substance). The remains of this glandular mass are seen in Ammocœtes in the peculiar so-called packing tissue around the brain and spinal cord (represented in Fig. 6 by the dark dotted substance). It satisfies the three tests to the following extent:—

(1) *The phylogenetic test.*—As we descend the vertebrate phylum, we find that the brain fills up the brain-case to a less and less extent, until finally in Ammocœtes a considerable space is left between brain and brain-case, filled up with a peculiar glandular-looking material, interspersed with pigment, which is

[1] Gaskell, *Journ. of Anat. and Physiol.*, vol. xxiii., 1888; *Journ. of Physiol.*, vol. x., 1889; *Brain*, vol. xii., 1889; *Q. J. of Micr. Sci.*, 1890.

not fat tissue, and is most marked in the lowest vertebrates. The natural interpretation of this phylogenetic history is that the cranial cavity is too large for the brain in the lowest vertebrates, and is filled up with a peculiar glandular substance because that glandular substance pre-existed as a functional organ or organs, and not because it was necessary to surround the brain with packing material in order to keep it steady, owing to the unfortunate mistake having been made of forming a brain much too small for its case.

(2) *The anatomical test* shows that this glandular and pigmented material is in the same position with respect to the central nervous system of Ammocœtes as the generative and liver material with respect to the central nervous system and alimentary canal of Limulus.

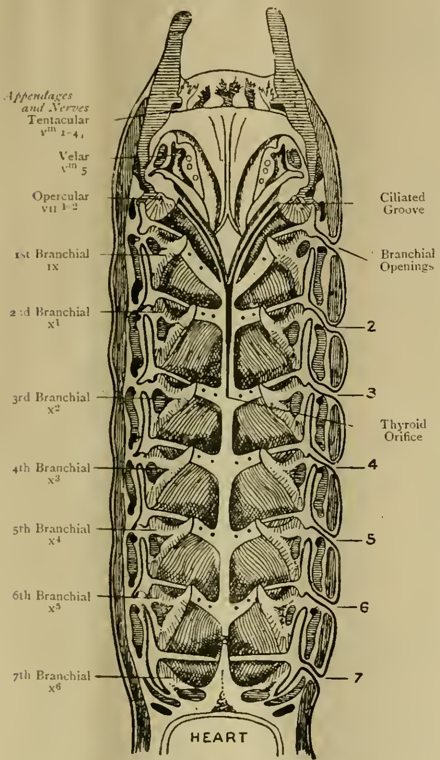


Fig. 3.—Head Region of Ammocœtes, split longitudinally into a ventral and dorsal half. (Ventral Half.)

(3) *The ontogenetic test* remains to be worked out. I do not know the origin of this tissue in Ammocœtes; the evidence has not yet been given by Kuppfer ("Studien z. vergleich. Entwicklungsgesch. d. Kopfes der Kranioten," 2 Heft, München u. Leipzig, 1894). He has, however, shown that the neural ridge gives origin to a mass of mesoblastic cells, the further fate of which is not worked out. The whole story is very suggestive from the point of view of my theory, but incomprehensible on the view that the neural ridge is altogether nervous.

Finally, we ought to find in the invertebrate group in question indications of the commencement of the enclosure of the alimentary canal by the central nervous system; such is, in fact, the case. In the scorpion group a marked process of cephalisation has gone on, so that the separate ganglia, both of the prosomatic and mesosomatic region, have fused together, and fused also with the large supra-œsophageal mass. In the middle of this large brain mass a small canal is seen closely surrounded and compressed with nervous matter, as is shown in this specimen of Thelyphonus; this canal is the alimentary canal. Again, Hardy, in his work on the nervous system of Crustacea, has sections through the brain of Branchipus which demonstrate so close an attachment between the nervous matter of the optic ganglion and the anterior diverticulum of the gut that no line of demarcation is visible between the cells of the gut wall and the cells of the optic ganglion.

For all these reasons I consider that the tubular nature of the vertebrate central nervous system is explained by my hypothesis much more satisfactorily and fully than by any other as yet put forward; it further follows that if this hypothesis enables us to homologise all the other parts of the head region of the verte-

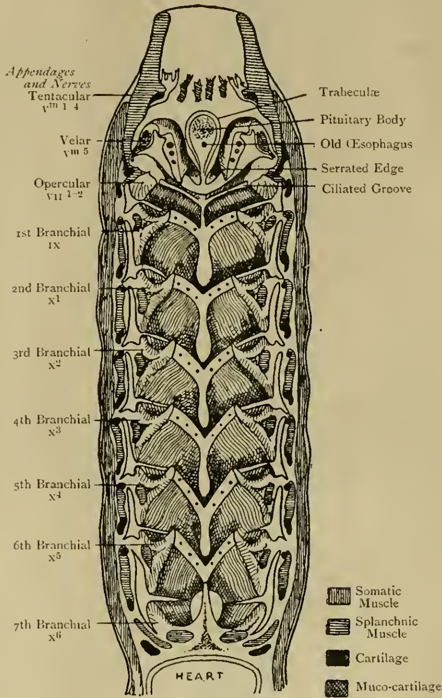


Fig. 3.—Head Region of Ammocœtes, split longitudinally into a ventral and dorsal half. (Dorsal Half.)

brate with similar parts in the arthropod, then it ceases to be an hypothesis, but rises to the dignity of the most probable theory of the origin of vertebrates.

Origin of Segmental Cranial Nerves.

1. *The phylogenetic test.*—It follows from the close resemblance of the brain region of the central nervous systems in the two groups of animals that the cranial nerves of the vertebrate must be homologous with the foremost nerves of such an animal as Limulus, and must therefore supply homologous organs. Leaving out of consideration for the present the nerves of special sense, it follows that the segmental cranial nerves must be divisible into two groups corresponding to two sets of segmental muscles, viz. a group supplying structures homologous to the appendages of Limulus and its allies, and a group supplying the somatic or body muscles; in other words, we must find precisely

what is the most marked characteristic of the vertebrate cranial nerves, viz. that they are divisible into two sets corresponding to a double segmentation in the head region. The one set, consisting of the Vth, VIIth, IXth, and Xth nerves, supply the muscles of the branchial or visceral segments; the other set, consisting of the IIIrd, IVth, VIth, and XIIth nerves, the muscles of the somatic segments. Further, we see that the

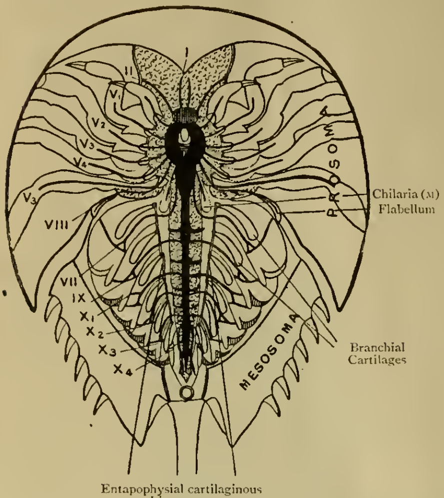


Fig. 4.—Limulus. Nerves of Appendages and Cartilages.

nerves supplying the branchial segments, like the nerves supplying the appendages in Limulus, are mixed motor and sensory, while the nerves supplying the somatic segments are all purely motor, the corresponding sensory nerves running separately as the ascending root of the fifth nerve; so also in Limulus, the nerves supplying the powerful body muscles arise separately

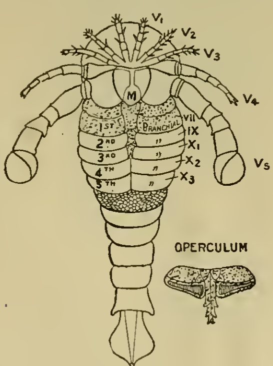


Fig. 5.—Eurypterus.

from those supplying the appendages, and also are quite separate from the purely sensory or epimeral (Milne Edwards, "Recherches sur l'Anatomie des Limulus," *Ann. des Sc. Nat.*, 5th ser.) nerves which supply the surfaces of the carapace in the prosomatic and mesosomatic regions. Finally, the researches of Hardy (*Phil. Trans. Roy. Soc.*, 1894) have shown that the motor portion of these appendage nerves, just like the nerves of the branchial segmentation in vertebrates, *i.e.* the motor part of the trigeminal, of the facial, of the glosso-pharyngeal, and of the vagus, arise from nerve centres or nuclei quite separate from those which give origin to the motor nerves of the somatic muscles. The phylogenetic history, then, of the cranial nerves points directly to the conclusion that the Vth, VIIth, IXth, and Xth nerves originally innervated structures of the nature of arthropod appendages.

We can, however, go further than this, for we find, as we trace downwards throughout the vertebrate kingdom the structures supplied by these nerves, that they are divisible into two well-marked groups, especially well seen in Ammocœtes, viz.:—

(1) A posterior group, viz. the VIIth, IXth, and Xth nerves, which arise from the medulla oblongata and supply all the structures within a branchial chamber.

(2) An anterior group, viz. the Vth nerves, which arise from the hind brain and supply all the structures within an oral chamber.

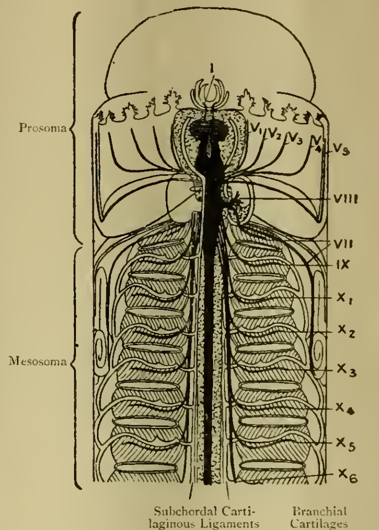


Fig. 6.—Ammocœtes. Nerves of visceral segments and cartilages.

In all three Figures V_1–V_5 = Prosomatic appendages and nerves; VII = 1st mesosomatic appendage or opercular appendage and nerves; IX, X_1 ... = remaining mesosomatic appendages and nerves; M = Chilaria in Limulus, metastoma in Eurypterus.

The reason for this grouping is seen when we turn to Limulus and its allies, for we find that the body is always divided into a prosoma and mesosoma, and that the appendage nerves are divisible into two corresponding well-marked groups, viz.:—

(1) A posterior or mesosomatic group, which arise from the mesosomatic ganglia and supply the operculum and branchial appendages.

(2) An anterior or prosomatic group, which arise from the prosomatic ganglia and supply the oral or locomotor appendages.

Comparison of the Branchial Appendages of Limulus, Eurypterus, &c., with the Branchial Appendages of Ammocœtes. Meaning of the IXth and Xth Nerves.

We will first consider the posterior group—the VIIth, IXth, and Xth nerves—and of these I will take the IXth and Xth nerves together, and discuss the VIIth separately. These nerves are always described as supplying in the fishes the muscles and other tissues in the walls of a series of gill-pouches, so that the respiratory chamber is considered to consist of a series of pouches, which open on the one hand into the alimentary canal, and on the other to the exterior. Such a

description is possible even as low down as Petromyzon, but when we pass to the Ammocœtes we find the arrangement of the branchial chamber has become so different that it is no longer possible to describe it in terms of gill-pouches. The nature of the branchial chamber is seen in Fig. 3, which demonstrates clearly that the IXth and Xth nerves supply a series of separate gill-bearing structures or appendages, which hang freely into a common respiratory chamber; each one of these appendages is moved by its own separate group of branchial muscles, and possesses an external branchial bar of cartilage, which, by its union with its fellows, contributes to form the extra-branchial basket-work so characteristic of this primitive respiratory chamber. The segmental branchial unit is clearly in this case, as Rathke originally pointed out, each one of these suspended gills, or rather gill-bearing appendages; it is absolutely unnatural, as Nestler (*Archiv f. Naturgeschich.*, 56, vol. i.) attempts to do, to take a portion of the space between two consecutive gills and call that a gill-pouch. It is, to my mind, one of the most extraordinary and confusing conceptions of the current morphology to describe an animal in terms of the spaces between organs, rather than in terms of the organs by which those spaces are formed. We might as well speak of a net as a number of h les tied together with string. Another most striking advantage is obtained by considering the segmental unit to be represented by each of these separate branchial appendages—viz. that we can continue the series in the most natural manner (as seen in Fig. 3) in front of the limits of the IXth and Xth nerves, and so find a series of appendages in the oral chamber serially homologous with the branchial appendages. The uppermost of the respiratory appendages is the hyo-branchial, supplied by the VIIth nerve, then, passing into the oral chamber, we find a series of non-branchial appendages, viz. the velar and tentacular appendages, supplied by branches of the Vth nerve. In fact, by simply considering the tissue between the so-called gill-pouches as the segmental unit, we no longer get lost in a maze of hypothetical gill pouches in front of the branchial region, but find that the resemblances between the oral and branchial regions, which have led to the endless search for gill-slits and gill-pouches, really mean that the oral chamber contains appendages just as the branchial chamber, but that the former were not gill-bearing

The study of Ammocœtes, then, leads directly to the conclusion that the ancestor of the vertebrate possessed an oral or prosomatic chamber, which contained a series of non-branchial, tactile and masticatory appendages, which were innervated from the fused prosomatic ganglia or hind brain, and a branchial or mesosomatic chamber, which contained a series of branchial appendages which were innervated from the fused mesosomatic ganglia or medulla oblongata. These two chambers did not originally communicate with each other, for the embryological evidence shows that they are separated at first by the septum of the stomatodæum, and also that the oral chamber is formed by the forward growth of the lower lip.

The phylogenetic test on the side of Limulus and its congeners agrees in a remarkable manner with the conclusions derived from the study of Ammocœtes, for we see that the variation which has occurred in the formation of Eurypterus from Limulus is exactly of the kind necessary to form the oral and branchial chambers of the Ammocœtes. Thus, we find with respect to the mesosomatic appendages that the free, many-jointed appendages of the crustacean become converted into the plate-like appendages of Limulus, in which the separate joints are still visible, but insignificant in comparison with the large branchiæ-bearing lamella; then comes the in-sinking of these appendages, as described by Macleod (*Archiv de Biologie*, vol. v., 1884) to form the branchial lamellæ, or so-called lung-books of Thelyphonus, and the branchiæ of Eurypterus, in which all semblance of jointed and free appendages disappears and the branchiæ project into a series of chambers or gill-pouches, each pair of which in Thelyphonus open freely into communication. In this way we see already the commencement of the formation of a branchial chamber similar to that of Ammocœtes.

So also with the innervation of these mesosomatic appendages, originally a series of separate mesosomatic ganglia, each of which innervates a separate appendage; then a process of cephalisation takes place, in consequence of which, in the first place, a single ganglion, the opercular ganglion, fuses with the already fused prosomatic ganglia, as is seen in the stage of Limulus; then, as pointed out by Lankester, in the different groups of scorpions more and more of the mesosomatic ganglia fuse together, and so we find the upward variation in this group is distinctly in the direction of the formation of the medulla oblongata coincidently with the formation of a branchial chamber.

In a precisely similar way, we find the variation which has occurred in the prosomatic appendages leads directly to the formation of the oral chamber and oral appendages of Ammocœtes; for the original chelate and locomotor appendages of Limulus become converted into the tactile non-chelate appendages of Eurypterus (*cf.* Figs. 4 and 5), and the small chilaria (M) of Limulus, according to Lankester, fuse in the middle line and grow forward to form the metastoma of Eurypterus, thus forming an oral chamber, into which the short tactile appendages could be withdrawn, closely similar in its formation to the oral chamber of Ammocœtes. The prosomatic ganglia supplying these oral appendages have already, in Limulus (see Fig. 4), been fused together to form the infra-œsophageal ganglia or hind brain.

The phylogenetic test, then, both on the side of the vertebrate and of the invertebrate, points direct to the conclusion that the peculiarities of the trigeminal and vagus groups of nerves are due to their origin from nerves supplying prosomatic and mesosomatic appendages respectively.

2. *The anatomical test* confirms and emphasises this conclusion in a most striking manner, for we find not only coincidence of topographical arrangement, as already mentioned, but also similarity of structure; thus we see that the blood in the gill lamellæ and velar appendages of Ammocœtes does not circulate in distinct capillaries, but, as in the arthropod appendages, in lacunar spaces, which by the subdivision of the surface of the appendage to form gill lamellæ become narrow channels; that also certain of the branchial muscles and of the muscles of the velar appendages are of the invertebrate type of so-called tubular muscles. These invertebrate muscles are not found in higher vertebrates, but only in Ammocœtes, and moreover disappear entirely at transformation.

Origin of the Vertebrate Cartilaginous Skeleton.

Perhaps, however, the most startling evidence in favour of the homology between the branchial segments of Ammocœtes and the branchial appendages of Limulus is found in the fact that a cartilaginous bar external to the branchiæ exists in each one of the branchial appendages of Limulus, to which some of the branchial muscles are attached in precisely the same way as in Ammocœtes. The branchial cartilages of Limulus (see Fig. 4) spring from the entapophyses and form strong cartilaginous bars, which are extra-branchial in position, just as in Ammocœtes; in addition to each branchial bar, a cartilaginous ligament passes from one entapophysis to another, so as to form a longitudinal or entapophysial ligament, more or less cartilaginous, which extends on each side along the length of the mesosoma. In precisely the same way the branchial bars of Ammocœtes are joined together along each side of the notochord by a ligamentous band of more or less continuous cartilaginous tissue, forming a subchordal or parachordal cartilaginous ligament.

Further, we see that this cartilage of Limulus is of a very striking structure, quite different from that of vertebrate cartilage, and that it is formed in a fibro-massive tissue which, like the matrix of the cartilage, gives a deep purple stain with thionin, thus showing the presence of some form of chondromucoid. This fibro-massive tissue is closely connected with the chitinogenous cells of the entapophyses.

Startling is it to find that the branchial cartilages of Ammocœtes possess identically the same structure as the cartilages of Limulus; that the branchial cartilages are formed in a fibro-massive tissue which, like the matrix of the cartilage, gives a deep purple stain with thionin, and that this fibro-massive tissue, to which Schneider ("Beiträge z. Anat. u. Entwicklungsgesch. der Wirbelthiere," Berlin, 1879) gives the name of muco-cartilage, or Vorknorpel, entirely disappears at transformation.

Further, according to Shipley (*Quart. Journ. of Micr. Sci.*, 1887), the cartilaginous skeleton of the Ammocœtes when first formed consists simply of a series of straight branchial bars, springing from a series of cartilaginous pieces arranged bilaterally along the notochord.

The formation of the trabeculæ, of the auditory capsules, of the crossbars to form the branchial basket-work, all occur subsequently, so that exactly those parts which alone exist in Limulus are those parts which alone exist at an early stage in

Ammocœtes. Another distinction is manifest between these branchial cartilages and those of the trabeculæ and auditory capsules, in that the latter do not stain in the same manner; whereas the matrix of the branchial cartilages stains red with picro-carmine, that of the trabeculæ and auditory capsules stains deep yellow, so that the junction between the trabeculæ and the first branchial bar is well marked by the transition from the one to the other kind of staining. The difference corresponds to Parker's (*Phil. Trans. Roy. Soc.*, 1883) soft and hard cartilage.

The new cartilages which are formed at transformation, either in places where muco-cartilage exists before or by the invasion of the fibrous tissue of the brain-case by chondroblasts, are all of the hard cartilage variety.

The phylogenetic, anatomical, and ontogenetic history of the formation of the vertebrate skeleton all show how the bony skeleton is formed from the cartilaginous, and how the cartilaginous skeleton can be traced back to that found in Petromyzon, and so to the still simpler form found in Ammocœtes; from this, again, we can pass directly to the cartilaginous skeleton of Limulus, and so finally trace back the cranial skeleton of the vertebrate to its commencement in the modified chitinous ingrowths connected with the entapophyses of Limulus. A similar explanation of the origin of cartilage from modifications of the chitinous ingrowths of Limulus was suggested by Gegenbauer ("Anat. Untersuch. eines Limulus," *Abhandl. der Naturf. Gesellsch. in Halle*) so long ago as 1858, in consideration of the near chemical resemblances between the chitin and mucin groups of substances.

Comparison of the Thyroid and Hyo-branchial Appendage of Ammocœtes with the Opercular Appendage of Eurypterus, Thelyphonus, &c. Meaning of the VIIth Nerve.

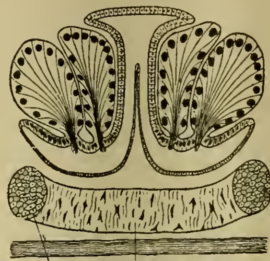
Seeing, then, how easily the IXth and Xth nerves in Ammocœtes correspond to the mesosomatic nerves to the branchial appendages in Limulus, and therefore to the corresponding nerves in such an animal as Eurypterus, we may with confidence proceed to the consideration of the VIIth nerve, and anticipate that it will be found to innervate a mesosomatic appendage in front of the branchial appendages, and yet belonging to the branchial group; in other words, if the VIIth nerve is to fit into the scheme, it ought to innervate a structure or structures corresponding to the operculum of Limulus or of Thelyphonus, &c. Now we see in Figs. 5 and 8 the nature of the operculum in Eurypterus and in Thelyphonus, Phrynus, &c. It is in reality composed of two parts, a median and anterior portion which bears on its under surface the external genital organs, and a posterior part which bears branchiæ; so that the operculum of these animals may be considered as a genital operculum fused to a branchial appendage, and therefore double. It is absolutely startling to find that the branchial segment immediately in front of the glosso-pharyngeal segment in Ammocœtes (Fig. 3) consists of two parts, of which the posterior, the hyo-branchial, is gill-bearing, while the anterior carries on its under surface the pseudo-branchial groove of Dohrn, which continues as a ciliated groove up to the opening of the thyroid gland.

Again, the comparison of the ventral surfaces of Eurypterus and Ammocœtes (*cf.* Fig. 8) brings to light a complete coincidence of position between the median tongue of the operculum in the one animal and the median plate of muco-cartilage in the other animal, which separates in so remarkable a manner the cartilaginous basket-work of each side, and bears on its under surface the thyroid gland. Finally, Miss Alcock has shown that not only the hyo-branchial, but also the thyroid part of this segment, is innervated by the VIIth nerve; so that every argument which has forced us to the conclusion that the glosso-pharyngeal and vagus nerves are the nerves which originally supplied branchial appendages equally points to the conclusion that the facial nerve originally supplied the opercular appendage—an appendage which closed the branchial chamber in front, which consisted of two parts, a branchial and a genital, probably indicating the fusion of two segments; and that the thyroid gland belonged to the genital operculum, just as the branchiæ belonged to the branchial operculum. This interpretation of the parts supplied by the facial nerve immediately explains why Dohrn is so anxious to make a thyroid segment in front of the branchial segments, and why a controversy is still going on as to whether the facial supplies two segments or one.

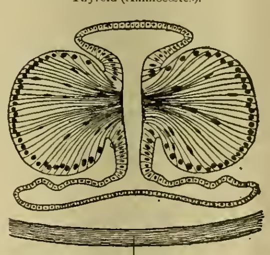
What, then, is the thyroid gland? Of all the organs found in the vertebrate, with perhaps the single exception of the pineal eye, there is no one which so clearly is a relic of the invertebrate ancestor as the thyroid gland. This gland, important as it is known to be in the higher vertebrates, remains of much the same type of structure down to the fishes, and even to Petromyzon; suddenly, when we pass to the Ammocœtes, to that larval condition so pregnant with invertebrate surprises, we find that the thyroid has become a large and important organ, totally different in structure from the thyroid of all other vertebrates, though resembling the endostyl of the Tunicates.

The thyroid of Ammocœtes may be described as a long tube, curled up at its posterior end, which contains in its wall, along the whole of its length, a peculiar glandular structure, confined to a small portion of its wall.

A section through this tube is given in Fig. 7, and shows how this glandular structure possesses no alveoli, no ducts, but consists of a column of elongated cells arranged in a wedge-shaped manner, the apex of the wedge being in the lumen of the tube;



Thyroid (Ammocœtes).



Thyroid (Scorpion).

FIG. 7.

each cell contains a spherical nucleus, situated at the very extreme end of the cell, farthest away from the lumen of the tube. Such a structure is different from that of any other vertebrate gland. Its secretion is not in any way evident. It certainly does not secrete mucus or take part in digestion, and for a long time I was unable to find any structure which resembled it in the least degree, apart, of course, from the endostyl of the Tunicates.

Guided, however, by the considerations already put forward, and feeling therefore convinced that in Eurypterus there must have been a structure resembling the thyroid gland underneath the median projection of the operculum, I proceeded to investigate the nature of the terminal genital apparatus underlying the operculum in the different members of the scorpion family, and reproduce here (Fig. 8) the figures given by Blanchard ("L'Organisation du Règne Animal") of the appearance of the terminal male genital organs in Phrynus and Thelyphonus. Emboldened by the striking appearance of these figures, I proceeded to cut sections through the operculum of the European scorpion, and found that that part of the genital duct which underlies the operculum, and that part only, contains within its

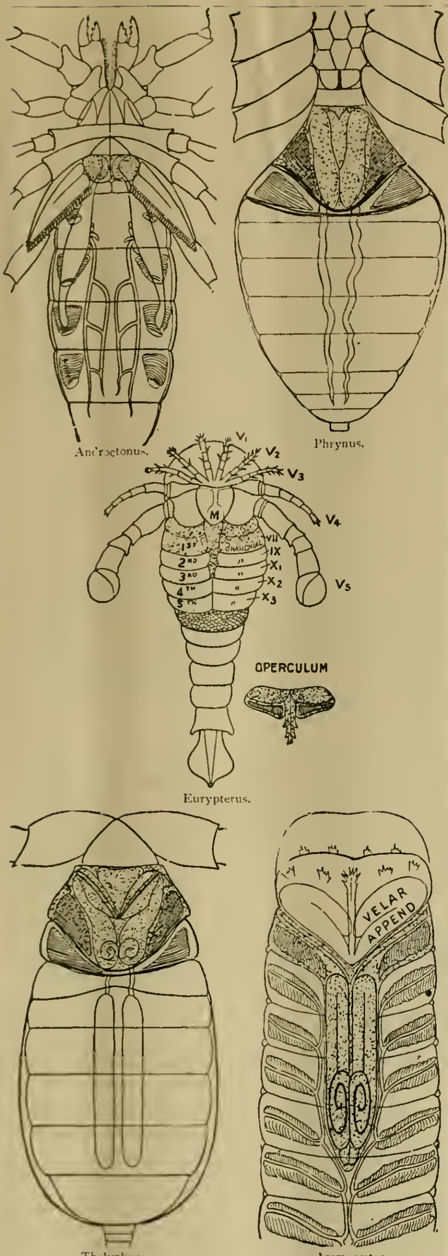


Fig. 8.—Comparison of the ventral surface of the branchial region. In all figures the opercular appendage is marked out by its dotted appearance.

walls a glandular structure which resembles the thyroid gland of Ammocœtes in a remarkable degree. A section is represented in Fig. 7, and we see that under the operculum in the middle line is situated a tube, the walls of which in one part on each side are thickened by the formation of a gland with long cells of the same kind as those of the thyroid; the nucleus is spherical, and situated at the farther end of the cell, and the cells are arranged in wedges, so that the extremities of each group of cells come to a point on the surface of the inner lining of the tube. This point is marked by a small round opening in the internal chitinous lining of the tube. These cells form a column along the whole length of the tube, just as in the thyroid gland, so that the chitinous lining along that column is perforated by numbers of small round holes. This glandular structure is not confined to the male scorpion, but is found also in the female, though not so well developed.

So characteristic is the structure, so different from anything else, that I have no hesitation in saying that the thyroid of Ammocœtes is the same structurally as the thyroid of the scorpion, and that, therefore, in all probability the median projection of the operculum in the old forms of scorpions, such as Eurypterus, Pterygotus, Slimonia, &c., covered a glandular tube of the same nature as the thyroid of Ammocœtes.

We see, then, that the structures innervated by the VIIth, IXth, and Xth nerves are absolutely concordant with the view that the primitive vertebrate respiratory chamber was formed from the mesosomatic appendages of such a form as Limulus by a slight modification of the method by which the respiratory apparatus of Thelyphonus and other Arachnids has been formed, according to Macleod. The anterior limit of this chamber was formed by the operculum, the basal part of which formed a septum which originally separated the branchial from the oral chamber.

Comparison of the Oral Chamber of Ammocœtes with that of Eurypterus. Meaning of the Vth Nerve.

Passing now to the oral chamber—*i.e.* to the visceral structures innervated by the Vth nerve—we find, as already suggested, distinct evidence in Ammocœtes of the presence of the modified prosomatic appendages of the original Eurypterus-like form. The large velar appendage is the least modified, possessing as it does the arthropod tubular muscles, a blood system of lacunar blood-spaces, and a surface covered with a regular scale-like pattern, formed by cuticular nodosites, similar to that found on the surface of Eurypterus and other scorpions. The velar appendages show, further, that they are serially homologous with the respiratory appendages, in that they have been utilised to assist in respiration, their movements being synchronous with the respiratory movements.

The separate part of the Vth nerve which supplies the velar appendage passes within it from the dorsal to the ventral part of the animal, and then, as Miss Alcock has shown, turns abruptly forward to supply the large median tentacle. This extraordinary course leads directly to the conclusion that this median tentacle, which is in reality double, constitutes, with the velum of each side, the true velar appendages.

Again, on each side of the middle line there are in Ammocœtes four large tentacles, each of which possesses a system of muscles, muco-cartilage, and blood-spaces, precisely similar to the median ventral tentacle already mentioned. Each of these is supplied, as Miss Alcock has shown, by a separate branch of the motor part of the Vth nerve (see Fig. 6), and each branch is comparable with the branch supplying the large velar appendage.

That such tentacles are not mere sensory papillæ surrounding the mouth, but have a distinct and important morphological meaning, is shown by the fact that they are transformed in the adult Petromyzon into the remarkable tongue and suctorial apparatus: a modification of oral appendages into a suctorial apparatus which is abundantly common among Arthropods.

Finally, the Vth nerve innervates the visceral muscles of the lower and upper lips of Ammocœtes. In order, then, for the story to be complete, the homologues of the lower and upper lips must also be found in the system of prosomatic appendages of forms like Limulus and Eurypterus. The lower lip, like the opercular or thyroid appendage, possesses a plate of muco-cartilage, and, as already mentioned, falls into its natural place as the metastoma of the old Eurypterus-like form, by the enlargement and forward growth of which the oral chamber of Ammocœtes was formed. The meaning of the upper lip will

be considered with the consideration of the old mouth-tube. The comparison of the metastoma of Eurypterus with the lower lip of Ammocœtes demonstrates the close resemblance between the oral chambers of Eurypterus and Ammocœtes. In order to obtain the condition of affairs in Ammocœtes from that in Eurypterus, it is only necessary that the metastoma should increase in size, and that the last oral appendage, the large oar-appendage, should follow the example of the other oral appendages, and be withdrawn into the oral cavity, and so form the velar appendage.

Thus we see that, just as the mesosomatic appendages of Limulus can be traced into the branchial and thyroid appendages of Ammocœtes through the intermediate stage of forms similar to Eurypterus, so also the prosomatic appendages and chilaria of Limulus can be traced into the velar and tentacular appendages and lower lip of Ammocœtes through the intermediate stage of forms similar to Eurypterus.

3. *Lastly comes the ontogenetic test.* The concordant interpretation of the origin of the motor part of the Vth, of the VIIth, IXth, and Xth nerves given by the anatomical and phylogenetic tests must explain and be illustrated by the facts of the development of Ammocœtes.

We see:—

(1) The oral chamber of Ammocœtes is known in its early stage by the name of the stomatodæum, and we find, as might be anticipated, that it is completely separated at first from the branchial chamber by the septum of the stomatodæum.

(2) This septum is the embryological representative of the basal part of the operculum, and demonstrates that originally the operculum separated the oral and branchial chambers.

(3) Subsequently these two chambers are put into communication by the breaking through of this septum, illustrating the communication between the two chambers by the separation of the median basal parts of the operculum.

(4) The velar appendages, the tentacular appendages, the lower lip, all form as out-buddings, just as the homologous locomotor appendages are formed in arthropods.

(5) The branchial bars are not formed by a series of inpouchings in a tube of uniform thickness, but, as Shipley (*loc. cit.*) has pointed out, by a series of ingrowths at regular intervals; in other words, the embryological history represents a series of buddings—*i.e.* appendages within the branchial chamber similar to the buddings within the oral chamber—and does not indicate the formation of gill-pouches by the thinning of an original thick tube at definite intervals.

(6) The communication of the branchial chamber with the exterior by the formation of the gill-slits represents a stage in the ancestral history which is conceivable, but cannot at present be explained with the same certainty as most of the embryological facts of vertebrate development. I can only say that Strubel (*Zool. Anzeiger*, vol. xv., 1892) has pointed out, and I can confirm him, that after the young Thelyphonus has left the egg, and is on its mother's back, before the moult which gives it the same form as the adult, the gills and gill-pouches are fully formed, but do not as yet communicate with the exterior.

(7) The branchial cartilages in the Ammocœtes are formed distinctly before the auditory capsules and trabeculæ, illustrative of the fact that they alone are formed in Limulus.

Comparison of the Auditory Apparatus of Ammocœtes with the Flabellum of Limulus. Meaning of the VIIIth Nerve.

The correctness of a theory is tested in two ways: (1) It must explain all known facts; and (2) it ought to bring to light what is as yet unknown, and the more it leads to the discovery of new facts, the more certain is it that the theory is true. So far, we see that the prosomatic and mesosomatic regions of the body in Limulus and the scorpions are comparable with the corresponding regions of Ammocœtes as far as their locomotor and branchial appendages are concerned, and that, therefore, a satisfactory explanation is given of the peculiarities of the Vth, VIIth, IXth, and Xth nerves. In all vertebrates, however, there is invariably found a special nerve, the VIIIth nerve, entirely confined to the innervation of the special sense organs of the auditory apparatus. It follows, therefore, that if my theory is true the VIIIth nerves must be found in such forms as Limulus and its allies, and that, therefore, a special sense-organ, probably auditory in nature, must exist between the prosomatic and mesosomatic appendages, at the very base of the last prosomatic appendage. At present we know nothing about the nature or locality of the hearing apparatus of Limulus. It is, therefore, all the more interesting to find that in the very position demanded by the theory, at the base of the last prosomatic appendage, is found a large hemispherical organ, to which a movable spatula-like process is attached, known by the name of the *flabellum*. This organ is confined to the base of this limb; it is undoubtedly a special sense-organ, being composed mainly of nerves, in connection with an elaborate arrangement of cells and innumerable fine hairs, which are thickly imbedded in the chitin of the upper surface of the spatula. The arrangement of these cells and hairs is somewhat similar to that of various sense-organs described by Gaubert (*Ann. d. Sci. Nat., Zool.*, 7th ser., tome 13, 1892), and supposed to be auditory. When the animal is at rest this sensory surface projects upwards and backwards into the crack between the prosomatic and mesosomatic carapaces, so that while the eyes only permit a look-out forwards and sidewards, and the whole animal is lying half buried in the sand, any vibrations in the water around can still pass through this open crevice, and so reach the sensory surface of this organ.

Finally, the most striking and complete evidence that this sense-organ of Limulus is homologous with the auditory capsule of Ammocœtes is found in the fact that in each case the nerve is accompanied into the capsule by a diverticulum of the liver and generative organs. (See dotted substance in Figs. 4 and 6). In Limulus the liver and generative organs, which surround the central nervous system from one end of the body to the other, do not penetrate into any of the appendages, with the single exception of the *flabellum*.

In Ammocœtes the peculiar glandular and pigmented tissue which surrounds the brain and spinal cord, and has already been recognised as the remains of the liver and generative organs, does not penetrate into the velar or other appendages, but is found only in the auditory capsule, where it enters with and partly surrounds the auditory nerve.

The coincidence is so startling and unexpected as to bring conviction to my mind that in the *flabellum* of Limulus we are observing the origin of the vertebrate auditory apparatus; and it is, to say the least of it, suggestive that in Galeodes the last locomotor appendage should carry the extraordinary racquet-shaped organs which Gaubert has shown to be sense-organs of a special character, and that in the scorpion a large special sense-organ of a corresponding character, viz. the pecten, should be found which, from its innervation, as given by Patten (*Quart. Journ. of Micr. Sci.*, vol. xxxi., 1890), appears to belong to the segment immediately anterior to the operculum, rather than to that immediately posterior to it.

Comparison of the Olfactory Organ of Ammocœtes with the Camerostome of Thelyphonus. Meaning of the Ist Nerve. Also comparison of the Hypophysis with the Mouth-tube of Thelyphonus.

In precisely the same way as the theory has led to the discovery of a special sense-organ in Limulus and its allies which may well be auditory, so also it must lead to the discovery of the olfactory apparatus of the same group, for here also, just as in the case of the auditory apparatus, we are at present entirely in the dark.

The olfactory organ in such an animal as Thelyphonus ought to be innervated from the supra-œsophageal ganglia, and ought to be situated in the middle line in front of the mouth. The mouth is at the anterior end in these animals, the lower lip or hypostoma (see Fig. 9) being formed by the median projecting flanges of the basal joints of the two pedipalpi; above, in the middle line, is a peculiar median appendage called the camerostome. Still more dorsal we find in the median line the rostrum, with the median eyes near its extremity, and laterally on each side of the camerostome, and dorsal to it, are situated the powerful cheliceræ, which are considered by some authorities to represent antennæ. Of these parts the camerostome is certainly innervated from the supra-œsophageal ganglia, and upon cutting sagittal transverse sections in a very young Thelyphonus we find that the surface is remarkably covered with very fine sense-hairs, arranged with great regularity and connected with a conspicuous mass of large cells. Upon making transverse sections through this region we see that the camerostome projects into the orifice of the mouth, and that its sense-epithelium forms, together with a similar epithelium on the lower lip, a closed cavity surrounded by a thick edge of fine hairs. Here, then, in the camerostome of Thelyphonus is a special sense-organ which, from its position and its innervation, may well be olfactory in function, or at all events subserve the function of taste.

Upon comparing this organ with the olfactory organ of Ammocœtes we see a most striking resemblance in general arrangement and structure.

Just as the mouth tube of Thelyphonus is formed of two parts, the pedipalp and camerostome, so, according to Kuppfer, the nasal tube of Ammocœtes is composed of two parts, the upper lip and the olfactory protuberance. Of these two parts we see that the upper lip, or hood, like the pedipalp, is innervated by the Vth nerve, or nerve of the prosomatic appendages, while the olfactory protuberance, like the camerostome, is innervated by the 1st nerve. Kuppfer's investigations show us further (Fig. 9) how the olfactory protuberance is at first free, is directed ventralwards, and lies at the opening of the hypophysial tube; how afterwards, by the forward and upward growth of the upper lip to form the hood, the nasal tube is formed with the result that the nasal opening lies on the dorsal surface just in

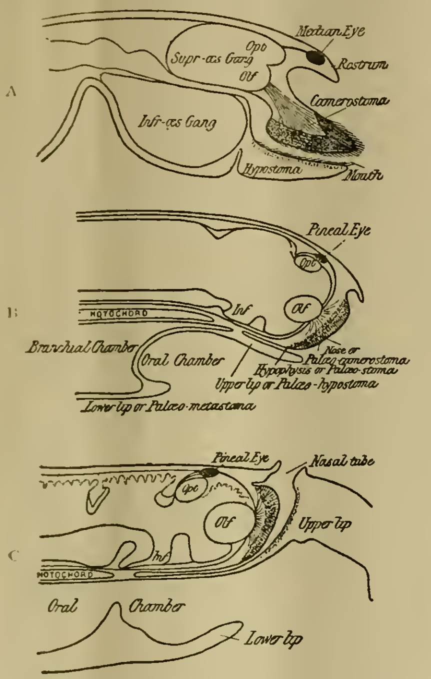


FIG. 9. A, median sagittal section through head of young Thelyphonus; B, ditto, young Ammocœte (after Kuppfer); C, ditto, full-grown Ammocœte (after Kuppfer).

front of the pineal eye. Kuppfer, like Dohrn and Beard, looks upon this hypophysial tube as indicating the palæostoma, or original mouth of the vertebrate, a view which harmonises absolutely with my theory, and receives the simplest of explanations from it, for, as you see on the screen, sections through the mouth tube of Thelyphonus correspond absolutely with sections through the nasal tube of Ammocœtes; here in the one section is the projecting camerostome, there is the corresponding projection of the olfactory protuberance, here is the sense-epithelium of the lower lip or hypostoma, there is the sense-epithelium of the upper lip or hood. Here, as Fig. 9 shows, the mouth tube passes in the ventral middle line to where it turns dorsalwards into the middle of the conjoined nervous mass of the supra- and infra-œsophageal ganglia. There the nasal tube ends blindly at the spot where the infundibular tube lies on the surface of the brain.

Further, the topography of corresponding parts is absolutely the same in the two animals: in the dorsal middle line the rostrum, with the two median eyes near its extremity; in the corresponding position the two pineal eyes; below this, in the middle line, the camerostome; corresponding to it in the Ammocœtes the olfactory protuberance; then the modification of the median projections of the foremost ventral appendages—the pedipalpi—to form the hypostoma. in the corresponding position the upper lip or hood of Ammocœtes, which forms the hypostoma as far as the hypophysial tube or palæostoma is concerned, but an upper lip as far as the new mouth is concerned. The muscles of this upper lip belong all to the splanchnic and not to the somatic group, and are innervated by the appropriate nerve of the prosomatic appendages, viz. the motor part of the Vth. Ventral to the pedipalpi in Thelyphonus there is nothing, ventral to the corresponding lip in the Ammocœtes is the lower lip, and we have seen that, although such a structure is absent in the land scorpions of the present day, it was present in the sea scorpions of old time, was known as the metastoma, and is supposed to be a forward growth which started at the junction of the prosoma with the mesosoma. Precisely corresponding to this we see from Kuppfer that the lower lip of Ammocœtes is a forward growth from the junction of the stomatodæum with the respiratory chamber.

We see then, so far, that the comparison of the vertebrate nervous system with the conjoined central nervous system and alimentary canal of the arthropod has led to a perfectly consistent explanation of almost all the peculiarities of the head region of Ammocœtes. We have solved the segmentation of the skull and the mysteries of the cranial nerves, for we have found that the cranial segmentation of the vertebrate can be reduced to the segmentation of the prosomatic and mesosomatic regions of the Limulus, that the cranial skeleton arose from the modified internal chitinous skeleton of the Limulus, that the new mouth was formed by the forward growth of the metastoma, leading to the formation of an oral chamber, while the old mouth remained as the hypophysial tube, guarded by its olfactory and taste organs.

Search as we may in the prososomatic and mesosmatic regions of scorpion-like animals, there are but few points left for elucidation; among these the most important are: (1) the fate of the cœlomic cavities and coxal gland; (2) the fate of the heart; (3) the fate of the external chitinous covering.

Comparison of the Head Cavities of the Vertebrate with the Prosomatic and Mesosomatic Cœlomic Spaces of Limulus.

A recent paper by Kishinouye (*Journ. of Coll. of Sci. Tokio*, vol. v., 1891) on the development of Limulus enables us to compare the cœlomic cavities in the head region of a vertebrate with those of the prosomatic and mesosomatic segments of Limulus, and we see that the comparison is wonderfully close; for whereas each mesosomatic segment possesses a cœlomic cavity, just as each of the segments of the branchial chamber supplied by the vagus, glossopharyngeal, and facial nerves possesses a cœlomic cavity, this is not the case with the prosomatic segments. In these latter the first cœlomic cavity is a large præoral one, common to the segment of the first appendage and all the segments in front of it; the segments belonging to the second, third, and fourth appendages have no cœlomic cavities formed in them, the second cœlomic cavity belongs to the segment of the fifth appendage. Similarly in the vertebrate in the region corresponding to the prosoma there are only two head cavities recognised, viz. the 1st præoral head cavity of Balfour and V. Wijhe; and 2nd or mandibular head cavity, associated especially with the Vth nerve. According to my view the motor part of the Vth nerve represents the locomotor prosomatic appendages of Limulus, and we see that already in Limulus the three foremost of these appendages do not form cœlomic cavities.

In fact, the agreement in the formation and position of the cœlomic cavities in the head region of the vertebrate and in the prosomatic and mesosomatic regions of Limulus could not well be more exact; further, these cavities agree in this, that in neither case are they permanent; both in the vertebrate and in the arthropod they are supplanted by vascular spaces.

Comparison of the Pituitary Gland with the Coxal Gland of Limulus.

In connection with the second cœlomic cavity in Limulus is found an ancient gland, partially degenerated according to some views, which was probably excretory in function, and has been

considered as homologous to the crustacean green glands. In a precisely corresponding position, and presenting a structure fairly similar to that of the coxal gland of Limulus, we find in Ammocœtes and in other vertebrates the pituitary gland. How far this gland tissue is developed in connection with the mandibular head cavity I do not know, but I venture to suggest that the complete evidence of its homology with the coxal gland will be found in its developmental connection with the walls of the 2nd or mandibular head cavity.

Comparison of the Vertebrate Heart and Ventral Aorta with the Ventral Longitudinal Branchial Sinuses of Limulus and its Allies.

The heart of the vertebrate presents two striking peculiarities, which make it different from all invertebrate hearts; first, its developmental history is different; and, secondly, it is at first essentially a branchial rather than a systemic heart. The researches of Paul Mayer (*Mitth. a. d. Zool. St. zu Neapel*, vol. vii.) have shown that the subintestinal vein, from which in the fishes the heart and ventral aorta arise, is in its origin double, so that in all vertebrates the heart and ventral aorta arise from two long veins which are originally situated on each side of the middle line. By the formation of the head fold these come together ventrally, coalesce into a single tube to form the subintestinal vein and heart, still remaining double as the two ventral aortæ with their branchial branches into each gill, as is well shown in the case of Ammocœtes.

It is a striking coincidence that in Limulus and the Scorpions two large venous collecting sinuses are found situated in the same ventral position, for the same purpose of sending blood to the branchiæ, as already described for the vertebrate; still more striking is it to find, according to the researches of Milne Edwards and Blanchard, that these longitudinal sinuses have already begun to function as branchial hearts, for they are connected with the pericardium by a system of transparent muscles, described by Milne Edwards and named by Lankester veno-pericardiac muscles. These muscles are hollow, both near the vein and near the pericardium, so that the blood in each case fills the cavity, and, as they contract with the heart, that part of them in connection with the venous collecting sinus already functions, as pointed out by Milne Edwards and Blanchard, as a branchial heart.

By this theory, then, even the formation of the vertebrate heart is prevised in Limulus, and I venture to think that in Ammocœtes we see the remnant of the old dorsal single heart of the arthropod in the form of that peculiar elongated organ composed of fattily degenerated tissue which lies between the spinal cord and the dorsal median skin.

Comparison of the Cuticular and Laminated Layers of the Skin of Ammocœtes with Chitinous Layers.

The external epithelial cells of Ammocœtes possess a remarkably thick cuticular layer. The striated appearance of this layer is due to a number of pores through which the glandular contents of the cells are poured when the surface is made to secrete. That this striated appearance is due to true porous canals, just as in chitin, and not to a series of rods, is easily seen by the inspection of sections, and also by watching the secretion through them of rose-coloured granules when the living cell is stained with methylene blue. The surface layer of this cuticular layer, according to Wolff (*Jen. Zeitschr.*, vol. xxiii.) resists reagents in the same manner as chitin.

Internal to the epithelial cells of the skin of Ammocœtes is a remarkable layer of tissue, generally called connective tissue. It resembles, however, histologically, in the Ammocœtes, a section through chitin most closely; the layers are perfectly regular and parallel; cells are found in it with great sparseness, and it is not until after transformation, when it is altered and invaded by new cell elements, that it can be looked upon as at all resembling connective tissue. It resembles chitin in its reaction to hypochlorite of soda. In order to completely dissect off this laminated layer from an Ammocœtes, all that is necessary is to place the animal in a weak solution of hypochlorite of soda, and in a short time it entirely disappears, bringing to view the muscles, branchial cartilages, pigment, front dorsal part of the central nervous system, &c., in a most striking manner. At present I am puzzled that so manifest a chitinous covering should lie internal to the epithelial cells of the surface; such a position is not, however, unknown among invertebrates, and may be accounted for in various ways.

For the sake of clearness I will sum up before you in the form of a table the corresponding parts in Ammocœtes and in Limulus and its allies, as far as I have discussed them up to the present, from which you will see that there is not a single organ which is present in the prosomatic and mesosomatic regions of Limulus and its allies which is not found in the corresponding situation and of corresponding structure in Ammocœtes.

Table of Coincidences between Limulus and its Allies, and between Ammocœtes and Vertebrates.

LIMULUS AND ITS ALLIES.	AMMOCŒTES AND VERTEBRATES.
Central Nervous System.	
Supra-œsophageal ganglia	Cerebral hemispheres.
Optic part	Optic thalami, ganglia habenulæ, &c.
Olfactory part	Olfactory lobes.
Œsophageal commissures	Crura cerebri.
Infra-œsophageal ganglia	Epichordal brain.
Prosomatic ganglia ...	Hind brain, cerebellum, post-corp. quadrig.
Mesosomatic ganglia ...	Medulla oblongata.
Ventral chain.	
Metasomatic ganglia ...	Spinal cord.
Alimentary Canal.	
Cephalic stomach	Ventricular cavities of brain.
Straight intestine	Central canal of spinal cord.
Terminal part	Neurenteric canal.
Œsophagus	Infundibular tube and saccus vasculosus.
Mouth tube	Hypophysial tube, later nasal canal.
Liver...	Part of subarachnoideal glandular tissue.
Appendages and Appendage Nerves.	
Prosomatic or locomotor appendages	Appendages of oral chamber or stomatodæum.
Foremost appendages...	Upper lip and tentacles.
Last appendages	Velar appendage and median ventral tentacle.
Metastoma	Lower lip.
Nerves of prosomatic appendages	Various branches of Vth nerve.
Mesosomatic or branchial appendages	Appendages of branchial chamber.
Opercular appendages	Appendage innervated by VIIth nerve.
Genital part	Thyroid gland and pseudo-branchial groove.
Branch. part	Hyobranchial.
Basal part...	Septum of stomatodæum.
Branchial appendages...	Branchial appendages innervated by IXth and Xth nerves.
Special Sense Organs and Nerves.	
Lateral eyes and optic nerves	Lateral eyes and optic nerves.
Median eyes and nerves...	Pineal eyes and nerves.
Camerostoma and olfactory nerves	Olfactory organ and Ist nerve.
Flabellum and nerve ...	Auditory organ and VIIIth nerve.
Epimeral nerves to surface of prosoma and mesosoma	Sensory part of Vth nerve.
Internal and External Skeleton.	
Internal skeleton.	
Branchial cartilages ...	Branchial cartilages.
Entapophysial cartilaginous ligaments ...	Subchordal cartilaginous ligaments.
Fibro-massive tissue (forerunner of cartilage or "Vorknorpel")	Muco-cartilage or "Vorknorpel."
External skeleton.	
Chitinous layer	Cuticular layer on surface of body and subepithelial laminated layer.

Excretory Organs and Cœlomic Cavities.	
Coxal gland	Pituitary gland.
1st head cavity, præoral...	1st head cavity, præoral.
2nd head cavity. Cavity of prosomatic segments	2nd head cavity, mandibular.
Cavities to each mesosomatic segment... ...	Cavities of hyoid and branchial segments.
Heart and Vascular System.	
Dorsal heart	Column of fatty tissue dorsal to spinal cord.
Longitudinal venous sinuses	Heart and ventral aorta.
Lacunar blood spaces of appendages	Lacunar blood spaces in velar and branchial appendages.

The Possible Meaning of the Notochord.

Although we can say that every structure and organ in the prosomatic and mesosomatic regions of Limulus, &c., is to be found in the head region of Ammocœtes, we cannot assert the reverse proposition, that every organ in the head region of Ammocœtes is to be found in Limulus, &c., for we find a notable exception in the case of the notochord, a structure which is *par excellence* a vertebrate structure, and has in consequence given the current name to the group. Such a structure is clearly not to be found in Limulus and its allies; it has evidently arisen in connection with the formation of the vertebrate alimentary canal from the oral and branchial chambers, and it evidently at one time possessed a functional significance, for the lower we descend in the vertebrate scale the more conspicuous it becomes.

Unfortunately we know nothing of the condition of the notochord in the early extinct fishes, so that we are reduced to the embryological method of inquiry in our endeavours to find out the meaning of this organ. This method appears to point to the origin of the notochord from a tube connected with the alimentary canal, originally therefore an accessory digestive tube; the reasons why such a view has been put forward are, first, the origin of the notochord from hypoblast; secondly, the evidence that it is to a certain extent tubular; and thirdly, that it is an unsegmented tube extending from the oral to the anal regions of the body. Another argument, to my mind stronger than any other, is based on the principle that nature repeats herself, and if, therefore, we find the same proliferation of cells in the same place forming a series of solid notochordal rods, we may fairly argue that we are observing a series of repetitions of the same process for the same object. Now the formation of the head region of Petromyzon shows that at first a median proliferation of hypoblastic cells occurs to form the notochord, which then separates off from the hypoblast; later on a similar proliferation takes place to form the subnotochordal rod, which similarly separates off from the hypoblast; later still, at the time of transformation, a third median proliferation of the cells of the hypoblast takes place, to form a solid rod of cells. This solid rod then commences to hollow out at the end nearest the intestine, and the hollowing out process extends gradually to the oral end, until a hollow tube is formed connecting the mouth with the intestine. In this way the new gut of the adult Petromyzon is formed from a solid median rod of cells closely resembling in its formation the original notochord.

I put it forward therefore as a suggestion, that in the ancient times when the Merostomata were lords of creation and the competition was keen among these ancient arthropod forms, in which the nervous system was so arranged that increase of brain substance tended more and more to compress the food channel, and therefore to compel to the suction of liquid food instead of the mastication of solid, accessory digestive apparatuses were formed, partly in connection with the formation of the oral respiratory chambers, and partly by means of the formation of the notochord. Of these accessory methods of digestion the former became permanent, while the latter becoming filled up with the peculiar notochordal tissue became a supporting structure, still showing by its unsegmented character its original function. That a tube formed from the external surface either as notochord or as the respiratory portion of the alimentary canal in Ammocœtes should be capable of acting as a digestive tube is clear from the researches of Miss Alcock (*Proc. Camb. Phil. Soc.*, vol. vii., 1891), for she has shown that the secretion of the skin of Ammocœtes easily digests fibrin in the presence of acid. Such a secretion, like the similar secretion of the carapace of Daphnia and other crustaceans, was originally for the purpose of keeping the skin clean.

The evidence which I have put before you is in agreement with the conclusion that the fore gut of the vertebrate arose gradually from a chamber formed by the lamellar branchial appendages, which functioned also as a digestive chamber. By the growth of the lower lip, or metastoma, and the modification of the basal portion of the last locomotor appendage, which basal part was inside the lower lip, into a valvular arrangement like the velum, the animal was able to close the opening into the respiratory chamber and feed as blood sucker in the way of the rest of its kind, or when living food was scarce, keep itself alive by the organic material taken into its respiratory chamber with the muddy water in which it lived.

The Possible Formation of the Vertebrate Spinal Region.

It remains to briefly indicate the evidence as to the formation of the rest of the alimentary canal and the spinal region of the body.

The problems connected with the formation of this region are of a different nature from those already considered in connection with the cranial region.

In the cranial region the variation that has taken place within the vertebrate group and in course of the formation of the vertebrate is, on the whole, of the nature called by Bateson substantive, *i.e.* increase or suppression of parts, while throughout the parts remain constant in their relations to each other. It matters not whether it is frog, fish, bird, or mammal we are considering: we always find the same cranial nerve supplying the same segments. When we consider the spinal cord and its immediate junction with the cranial region, this is no longer so; here we find a repetition of similar segments, with great variation in the amount of that repetition; here we find the characteristic feature is meristic variation rather than substantive, and so indetermined is the vertebrate in this respect that even now the same species of animal varies in the number of its segments and in the arrangement of its nerves. In this part of the vertebrate body this repetition is seen not only in the central nervous system and its nerves, but also in the excretory organs, so that embryology teaches us that the vertebrate body has grown in length by a series of repetitions of similar segments formed between the head end and the tail end; such lengthening by repetition of segments has been accompanied by the elongation of the unsegmented gut, of the unsegmented notochord, and of the unsegmented neural canal.

To put it shortly, all the evidence points to and confirms the view so strongly urged by Gegenbauer, that the head region is the oldest part and the spinal region an afterthought, that the attempt so often made to find vertebræ and spinal nerves in the cranial region is an attempt to put the cart in front of the horse—to obtain youth from old age. We may, it seems to me, fairly argue from the sequence of events in the embryology of vertebrates that the primitive vertebrate form was chiefly composed of the head region, and that between the head and the tail was a short body region. In other words, the respiratory chamber and the cloacal region were originally close together, just as would be the case in Limulus if the branchial appendages formed a closed chamber. According, then, to my view, there would be no difficulty in the respiratory chamber opening originally into the cloacal region, *i.e.* the same cloacal region into which the neurenteric canal already opened. The short junction tube thus formed would naturally elongate with the elongation of the body, and, as it originally was part of the respiratory chamber, it equally naturally is innervated by the vagus nerve. This, then, is the explanation of that most extraordinary fact, viz. that a nerve essentially branchial should innervate the whole of the intestine except the cloacal region. Whether this is the true explanation of the formation of the mid-gut of the vertebrate cannot be tested directly, but certain corollaries ought to follow: we ought to find, on the ground that the sequence of the phylogenetic history is repeated in the embryo, that (1) the growth in length of the embryo takes place between the cranial and sacral regions by the addition of new segments from the cranial end; (2) the formation of the fore-gut and hind-gut ought to be completed while the mid-gut is still an undifferentiated mass of yolk cells; (3) the cloacal region ought to be innervated from the sacral nerves, while the stomach, mid-gut and its appendages, liver and pancreas, ought to be innervated from the vagus.

The first proposition is a well-known embryological fact. The second proposition is also well known for all vertebrates, and is especially well exemplified in the embryological development of Ammocœtes, according to Shipley. The third proposition is also well known, and has received valuable enlargement in the recent researches of Langley and Anderson (*Journ. of Physiology*, vols. xviii., xix.).

Further, we see that in this part of the body the ancestor of the vertebrate must have had a cœlomic cavity the walls of which were innervated, not from the mesosomatic nerves or respiratory nerves, but from the metasomatic group of nerves; and in connection with this body cavity there must have existed a kidney apparatus, also innervated by the metasomatic nerves; with the repetition of segments by which the elongation of the animal was brought about the body cavity was elongated, and the kidney increased by the repetition of similar excretory organs. All, then, that is required in the original ancestor in order to obtain the permanent body cavity and urinary organs characteristic of the vertebrate is to postulate the presence of a permanent body cavity in connection with a single pair of urinary tubes in the metasomatic region of the body. As yet I have not worked out this part of my theory, and am therefore strongly disinclined to make any assertions on the subject. I should like, however, to point out that, according to Kishinouye (*Journ. of Coll. of Sci. Tokio*, vol. iv. 1890, vol. vi. 1894), a permanent body cavity does exist in this part of the body in spiders, known by the name of the stercoral pocket; into this cœlomic cavity the excretory Malphigian tubes open.

The Palæontological Evidence.

It is clear, from what has already been said, that the palæontological evidence ought to show, first, that the vertebrates appeared when the waters of the ocean were peopled with the forefathers of the Crustacea and Arachnida, and, secondly, the earliest fish-like forms ought to be characterised by the presence of a large cephalic part to which is attached an insignificant body and tail.

Such was manifestly the case, for the earliest fish-like forms appear in the midst of and succeed to the great era of strange proto-crustacean animals, when the sea swarmed with Trilobites, Eurypterus, Slimonia, Limulus, Pterygotus, Ceratiocaris, and a number of other semi-crustacean, semi-arachnid creatures. When we examine these ancient fishes we find such forms as Pteraspis, Pterichthys, Astrolepis, Bothriolepis, Cephalaspis, all characterised by the enormous disproportion between the extent of the head region and that of the body. Such forms would have but small power of locomotion, and further evolution consisted in gaining greater rapidity and freedom of movements by the elongation of the abdominal and tail regions, with the result that the head region became less and less prominent, until finally the ordinary fish-like form was evolved, in which the head and gills represent the original head and branchial chamber, and the flexible body, with its lateral line nerve and intestine innervated by the vagus nerve, represents the original small tail-like body of such a form as Pterichthys.

Nay, more, the very form of Pterichthys and the nature of its two large oar-like appendages, which, according to Traquair, are hollow, like the legs of insects, suggest a form like Eurypterus, in which the remaining locomotor appendages had shrunk to tentacles, as in Ammocœtes, while the large oar-like appendages still remained, coming out between the upper and lower lips and assisting locomotion. The Ammocœtes-like forms which in all probability existed between the time of Eurypterus and the time of Pterichthys have not yet been found, owing possibly to the absence of chitin and of bone in these transition forms, unless we may count among them the recent find by Traquair of Palæospondylus Gunni.

The evidence of palæontology, as far as it goes, confirms absolutely the evidence of anatomy, physiology, phylogeny, and embryology, and assists in forming a perfectly consistent and harmonious account of the origin of vertebrates, the whole evidence showing how nature made a great mistake, how excellently she rectified it, and thereby formed the new and mighty kingdon of the Vertebrata.

Consideration of Rival Theories.

In conclusion I would ask, What are the alternative theories of the origin of vertebrates? It is a strange and striking fact how often, when a comparative anatomist studies a particular invertebrate group, he is sure to find the vertebrate at the end of it: it matters not whether it is the Nemertines, the Capitellidæ, Balanoglossus, the Helminths, Annelids, or Echinoderms; the ancestor of the vertebrate is bound to be in that particular group. Verily I believe the Mollusca alone have not yet found a champion. On the whole I imagine that two views are most prominent at the present day: (1) to derive vertebrates from a group of animals in which the alimentary canal has always been ventral to the nervous system; and (2) to derive vertebrates from the appendiculate group of animals, especially annelids, by the supposition that the dorsal gut of the latter has become the ventral gut of the former by reversion of surfaces. Upon this latter theory, whether it is Dohrn or van Beneden or Patten who attempts to homologise similar parts, it is highly amusing to see the hopeless confusion into which they one and all get, and the extraordinary hypotheses put forward to explain the fact that the gut no longer pierces the brain. One favourite method is to cut off the most important part of the animal, viz. his supra-œsophageal ganglia, then let the mouth open at the anterior end of the body, turn the animal over, so that the gut is now ventral, and let a new brain, with new eyes, new olfactory organs, grow forward from the infra-œsophageal ganglia. Another ingenious method is to separate the two supra-œsophageal ganglia, let the mouth tube sling round through the separated ganglia from ventral to dorsal side, then join up the ganglia and reverse the animal. The old attempts of Owen and Dohrn to pierce the dorsal part of the brain with the gut tube either in the region of the pineal eye or of the fourth ventricle have been given up as hopeless. Still the annelid theory, with its reversal of surfaces, lingers on, even though the fact of the median pineal eye is sufficient alone to show its absolute worthlessness.

Then, as to the other view, what a demand does that make upon our credulity! We are to suppose that a whole series of animals has existed on the earth, the development of which has run parallel with that of the great group of appendiculate animals, but throughout the group the nervous system has always been dorsal to the alimentary canal. Of this great group no trace remains, either alive at the present day or in the record of the rocks, except one or two aberrant, doubtful forms, and the group of Tunicates and Amphioxus, both of which are to be looked upon as degenerate vertebrates, and indeed are more nearly allied to the Ammocœtes than to any other animal. This hypothetical group does not attempt to explain any of the peculiarities of the central nervous system of vertebrates; its advocates, in the words of Lankester, regard the tubular condition of the central nervous system as in its origin a purely developmental feature, possessing no phylogenetic importance. Strange power of mimicry in nature, that a tube so formed should mimic in its terminations, in its swellings, in the whole of its topographical relations to the nervous masses surrounding it the alimentary canal of the other great group of segmented animals so closely as to enable me to put before you so large a number of coincidences.

Just imagine to yourselves what we are required to believe! We are to suppose that two groups of animals have diverged from a common stock somewhere in the region of the Cœlenterata, that each group has become segmented and elongated, but that throughout their evolution the one group has possessed a ventral mouth, with a ventral nervous system and a dorsal gut, while in the other—the hypothetical group—the mouth and gut have throughout been ventral and the nervous system dorsal. Then we are further to suppose that, without being able to trace the steps of the process, the central nervous system in the final members of this hypothetical group has taken on a tubular form of so striking a character that every part of this dorsal nerve-tube can be compared to the dorsal alimentary tube of the other great group of appendiculate animals. The plain, straightforward interpretation of the facts is what I have put before you, and those who oppose this interpretation and hold to the inviolability of the alimentary canal are, it seems to me, bound to give a satisfactory explanation of the vertebrate nervous system and pineal eye. The time is coming, and indeed has come, when the fetish-worship of the hypoblast will give way to the acknowledgment that the soul of every individual is to be found in the brain, and not in the stomach, and that the true principle of evolution, without which no upward progress is possible, consists in the steady upward development of the central nervous system.

In conclusion I would like to quote to you a part of the last letter I ever received from Prof. Huxley, in which, with reference

to this very subject, he wrote as follows: "Go on and prosper, there is nothing in the world of science half so good as an earthquake hypothesis, even if it only serve to show how firm are the foundations on which we build." I have given you the earthquake hypothesis; it is for those of you who oppose my conclusions, to prove the firmness of your foundations.

PHYSICS AT THE BRITISH ASSOCIATION.

PERHAPS Section A does not discuss the question of science teaching in schools so often as Section B does. But the many teachers of science who listened to the address of the President (Prof. J. J. Thomson) on Thursday, must have heard with pleasure the testimony of so competent an authority that the teaching of physical science in schools has greatly improved in recent years. Very welcome, too, was his advice as to the importance of experimental work and method in teaching, and his warning as to the danger of trying to cover too much ground. The Section was favoured with the presence of physicists from various foreign countries, including Profs. Kohlrausch (Director of the Reichsanstalt), Lenard (Aachen), Bjerknes (Stockholm), J. E. Keeler (Pittsburg), Max Wolf (Heidelberg), and Elster and Geitel (Wolfenbüttel). The mention of Prof. Lenard's name in the President's address was the signa for very hearty applause.

After the President's address, the Section adjourned from the Arts Theatre to the Physics Theatre. The Report of the Committee on the Establishment of a National Physical Laboratory was presented by Sir Douglas Galton, who gave details of the cost of the Reichsanstalt, where the capital expenditure has amounted to £200,000, and the annual working expenses are £14,500. The Committee was appointed last year (see NATURE, September 26, 1895) to consider—or rather to reconsider—a suggestion made by Prof. Oliver Lodge at the Oxford meeting. It now proposes that the Kew Observatory at Richmond be extended so as to include a nucleus for the suggested National Physical Laboratory, and that the Government be approached with a request for the modest sum of about £20,000 for buildings and equipment, and £3000 per annum for maintenance. The control of the laboratory should be vested in a Council of Advice appointed by the Royal Society, either alone (like the present Kew Committee) or in conjunction with one or more of the chief scientific bodies in the country; but the immediate executive and initiative power should be vested in a paid chief or director of the utmost eminence attainable. The functions of the institution would include an extension of certain branches of work now performed by the Kew Observatory, such as the verification of standards and comparisons of length, weight, capacity, gravity, sound, light, &c., and variations of conditions due to temperature, vibrations, or other causes, as well as quality of materials. Research work of the following types should also be undertaken: (1) observations of phenomena, the study of which must be prolonged through periods greater than the average duration of life; (2) testing and verification of instruments for physical investigation, and the preservation of standards for reference; (3) systematic determination of physical constants and numerical data which may be useful for scientific or industrial purposes. In the discussion which followed, Lord Kelvin, Profs. Lodge, Ayrton, Fitzgerald, Rücker, and S. P. Thompson, and the Director of the Reichsanstalt took part. Dr. Isaac Roberts read a paper, in which he dealt with the analytic and synthetic methods of tracing the evolution of stellar systems. Very beautiful photographs of stars and nebulæ (taken with about four hours' exposure) were projected on the screen. Prof. G. H. Darwin read a paper on periodic orbits, which Lord Kelvin characterised as a monument of skilful and painstaking calculation. In the afternoon Prof. McKendrick gave a most interesting demonstration of a method of transcribing wave forms from a phonograph cylinder to paper, with other experiments illustrating his researches on the phonograph. During the week a number of instruments and exhibits were on view in the physical laboratory. These included the apparatus with which Dr. Lodge has sought to determine whether a moving body sets the ether in its neighbourhood in motion; X-ray tubes and photographs taken with them; a large influence machine; Prof. Lodge's electrostatic model; and Mr. Barlow's model illustrating the nature of homogeneity in crystals.

On Friday there was a joint discussion with Section B on Rontgen rays and allied phenomena. The interest felt in these was evidenced by the large attendance, many members having to content themselves with seats in the gallery of the large lecture theatre of University College. The subject was appropriately introduced by Prof. P. Lenard, who described his researches on kathode rays, and his views as to their nature. The separation of these rays was made possible by Hertz's discovery that they can pass through thin plates or films, *e.g.* of aluminium. Lenard's discharge tube had an aluminium window at the end opposite the kathode. Aluminium is a turbid medium for these rays, so that in passing through the window they are diffused. They are almost invisible in air, which is only very faintly illuminated by them; they are also largely absorbed by air, so that their intensity diminishes very quickly. If the tube is continued beyond the aluminium window, and the pressure of the air in this second chamber is reduced, the rays travel much further. This favours the view that they are not due to projected matter, but are of the nature of ether-waves. By placing a second screen with a diaphragm beyond the aluminium window a more distinct beam is obtained, and this is allowed to fall upon a phosphorescent screen. By introducing plates of metal in the path of the rays, it is found that their opacity is roughly proportional to their superficial density (gm. per sq. cm.). The same is true for gases; air can be made as transparent as hydrogen by reducing its pressure. Kathode rays exhibit differences in degree analogous to those of differently coloured lights; these differences can be exhibited by varying the pressure in the discharge tube, and observing the different amounts of deflection produced by a magnet. By reducing the pressure we get less deflectible rays; these are the least absorbed by ordinary matter, and are the easiest to investigate. X-rays are of this nature; they travel easily through air, and may be regarded as kathode rays which can only be very slightly affected by a magnet. They were probably present in Lenard's experiments, but must have been very faint, for the aluminium window was small and (on account of the pressure) not very thin. Prof. Lenard subsequently exhibited his experiments in the physical laboratory.

In the discussion which followed, Sir George Stokes maintained the view that the rays are due to projected matter. The inside of the aluminium window is bombarded by molecules of gas or by particles discharged from the electrode. Why should not this bombardment give rise to a corresponding projection of molecules from the outside of the window? It is not necessary to suppose that they pass through the window. We have an analogue in the electrolysis of copper sulphate between copper electrodes. If a third (idle) electrode is introduced between them, we find that copper ions are deposited on one side of it and removed from the other. The absence of diffraction effects and other properties favour the view that X-rays are due to sudden and non-periodic disturbances. Prof. Fitzgerald congratulated Prof. Lenard on his skilful investigation, and pointed out that, whereas Röntgen's experiments had soon been repeated by hundreds of observers, Lenard's earlier experiments were of such a difficult nature that no one had since repeated them. Although Hertz held that the kathode rays were due to ethereal vibrations, his own suggestion that their deflection by a magnet may be analogous to the Hall effect tells against this view; for the Hall effect only occurs when matter is present. Again, Hertz found support for his views in his remarkable discovery that a magnet was not deflected by kathode rays. He does not seem to have considered that corresponding to the direct conduction current in the tube there must be a reverse convection current outside. Would not this back current neutralise the effect of the first convection current? Or the explanation may simply be that the effect upon a magnet is so slight that we cannot detect it. Prof. J. J. Thomson gave an account of experiments, made by himself and Mr. E. Rutherford, on the laws of conduction of electricity through gases exposed to the Röntgen rays. These rays convert gases into conductors, and the gas retains its conducting power for some time after the rays have ceased to pass. When the gas is forced through a wire gauze or muslin strainer into another vessel, it still conducts; but filtering through glass wool removes the conducting power, and so does bubbling through water. It is remarkable that the passage of a moderate electric current through the gas entirely destroys the conductivity; even very small currents reduce it considerably. This seems to indicate that the conduction is electrolytic. A theory based on this assumption has been tested by quantitative measurements, and the results are in satisfactory accordance with the theory. For an E.M.F. of 1 volt per cm. the ionic velocity is between 1 mm.

and $\frac{1}{3}$ mm. per sec. (or of that order). There are extraordinary differences between the rates of leakage in different gases; roughly they follow a density law. Thus mercury vapour (which is one of the best insulators) is here found to become the best conductor. Chlorine, bromine, and iodine come next. Sulphuretted hydrogen conducts better than oxygen. But the rates depend on the slope of potential used, and the order may even be reversed (as in the case of air and hydrogen). Another remarkable result of the experiments is to show that the conductivity under the action of X-rays increases when the length of the column of gas between the electrodes is increased; this is intelligible on the electrolytic theory just referred to and is, indeed, required by it. Prof. Ayrton pointed out that a similar phenomenon is observed in arc lamps worked at a constant potential; when the length of the arc is increased, the current at the same time increases. Prof. Rücker made a preliminary communication on measurements of transparency of glass and porcelain to Röntgen rays, made by himself and Mr. Watson. A colour-patch photometric method was employed, in which the light produced by the rays on a phosphorescent screen was compared with light from an arc lamp which had passed through two thicknesses of cobalt glass. Assuming the law of inverse squares, it is found for glass that the intensity of the transmitted light is given by $I = I_0 (A + B^t)$ where I_0 is the intensity of the incident light and t the thickness of the glass. Certain kinds of china are almost as transparent as glass; but others, in the manufacture of which bone ash is used, are very opaque. This method of examination may prove of service to collectors of porcelain and china. Lord Kelvin made a preliminary communication on measurements (by himself, Dr. Bottomley, and Dr. Maclean) of electric currents through air at different densities down to one five-millionth of the density of ordinary air. At a distance of 1·5 mm. between needle-points an E.M.F. below 1000 volts produces no current. 2000 volts produces an appreciable current which increases rapidly from 2000 to 8000 volts. A curve having volts as abscissæ, and galvanometer readings as ordinates, is always convex to the axis of abscissæ. The above measurements were made at the ordinary pressure; at a pressure of one thousandth of an atmosphere (0·75 mm.) a few score of volts would start a current. Dr. F. T. Trouton communicated the results of experiments on the duration of X-radiation at each spark, made by rotating a wheel between the discharge tube and a sensitive plate. The duration varies between 1/300th and 1/10,000th of a second, but the results are dependent on the nature of the plate used. Prof. S. P. Thompson read a paper on the relation between kathode rays, X-rays, and Becquerel's rays. Interesting experiments were described in which various screens and obstacles were introduced inside a Crookes tube. In one of these the discharge from a concave kathode was allowed to fall on a flat anti-kathode inclined at 45°, and then on to two aluminium wires as obstacles in front of the wall of the bulb. At a low degree of exhaustion kathode rays are produced which throw shadows of the wires on the bulb, but no shadow on a fluorescent screen outside. The position of the shadows on the bulb can be shifted by a magnet. At a high degree of exhaustion we get X-rays which throw shadows on a fluorescent screen outside. These are not shifted directly by a magnet, excepting that the magnet shifts the hot point of the kathode rays on the anti-kathode. At an intermediate degree of exhaustion both shadows can be seen simultaneously. The kathode shadows contract when the wires are electrified positively, and expand when they are electrified negatively; the X-shadows are not affected by electrifying the wires.

On Saturday the Section divided into two departments. In the department of Physics the Report of the Committee on the Comparison and Reduction of Magnetic Observations was presented. Prof. Rücker presented the Report of the Committee on Magnetic Standards. A survey instrument previously compared with Kew has been taken to three observatories and compared with the instruments at these. Prof. Rücker visited Falmouth, and Mr. W. Watson Valencia and Stonyhurst. The differences from Kew are given below:

	Falmouth.	Stonyhurst.	Valencia.
Declination	− 0·2 ...	+ 1·1 ...	± 0·0
H × 10^{-5} C.G.S. ...	− 18 ...	− 6 ...	+ 29
Dip	− 1′·6 ...	+ 2′·2 ...	− 1′·8

In the course of the adjourned discussion on Prof. S. P. Thompson's paper (read on Friday), Prof. V. Bjerknes stated that M. Birkeland (of Kristiania) had recently observed a discontinuous line spectrum of kathode rays produced by magnetic deflection. The rays are allowed to pass through an aperture in a metallic screen inside the tube, and their position, after deflection, is observed by means of the fluorescence on the wall of the tube. When the pressure is high only a single line is observed, but when the pressure is reduced new lines make their appearance. The spectrum is not continuous, as Lenard had supposed, but is discontinuous like the line spectrum of a gas. This supports the view that the rays are due to ethereal vibrations. The observations are rather difficult on account of flickering. Three or four bright lines are distinctly seen, but probably there are thirty or forty present. Prof. S. P. Thompson read a further paper on "hyper-phosphorescence"—the term hyper-phosphorescent being applied to bodies which, after due stimulus, exhibit a persistent emission of invisible rays not included in the hitherto recognised spectrum. In endeavouring to shorten the time of exposure in photographing with X-rays, the action of fluorescent substances, such as calcium sulphide, zinc sulphide, and fluoride of uranium and ammonium, was tested. The plates were found to become fogged by these materials, although they had been kept in the dark long enough for all visible phosphorescence to disappear. Even after being kept in the dark for six weeks calcium sulphide actively emits rays that affect a photographic plate. Experiments were made to test whether sunlight, or the light from an arc lamp, contains any radiation which will pass, like the X-rays, through opaque bodies. From an arc lamp, with an exposure of two hours, photographic shadows of pieces of metal were obtained through pine-wood several millimetres thick; but aluminium was quite opaque to everything radiated from the arc and to sunlight. Fluorescent substances were next placed on top of an aluminium plate below which was a photographic plate; and the whole was exposed to dull sunlight for several hours. Photographic action was found to have taken place (through the aluminium) behind the portions where uranium nitrate and uranium ammonium fluoride had been placed. These effects are inconsistent with a law enunciated by Stokes—but which he has since modified. When they were communicated to Sir George Stokes, he drew the speaker's attention to the remarkable results obtained by Becquerel in the same direction. The Becquerel rays differ from the X-rays in that they can be refracted and polarised; they are probably transverse waves of an exceedingly high ultra-violet order.

In the department of Mathematics a Report was presented on the G (r, ν) Integrals; also the Report of the Committee on Bessel Functions and other Mathematical Tables. Papers were read by the Rev. R. Harley, on results connected with the theory of differential resolvents; by Lieut.-Colonel A. Cunningham, on the connection of quadratic forms; by Mr. H. M. Taylor, on great circle sailing; by Mr. S. H. Burbury, on the stationary motion of a system of equal elastic spheres; and by Mr. G. H. Bryan, on some difficulties connected with the kinetic theory of gases.

On Monday the Section again met in two departments. In the Physics Theatre, Lord Kelvin gave an account of experiments made by himself, Dr. Maclean and Mr. Galt, on the communication of electricity from electrified steam to air; and also contributed a paper on the molecular dynamics of hydrogen gas, oxygen gas, ozone, peroxide of hydrogen, vapour of water, liquid water, ice, and quartz crystal. Taking hydrogen and oxygen and their compounds first, it is assumed that there are two kinds of atom, h, o, with the distinction that the force between two h's and the force between two o's and the force between an h and an o are generally different. The mutual force between two h's is always the same at the same distance; so is the force between two o's and between an h and an o. The atoms are considered as points acting on one another with forces in the lines joining them; no further assumption is made beyond the conferring of inertia upon these Boscovich atoms. It is shown that the known chemical and physical properties of the substances named can be explained by making H consist of two Boscovich atoms (h, h) and O of two others (o, o). This makes H_2 consist of four h's at the corners of an equilateral tetrahedron, and O_2 a similar configuration of four o's. It naturally shows ozone as six o's at the corners of a regular octahedron; and peroxide of hydrogen as a tetrahedron of h's symmetrically placed within a tetrahedron of o's. It makes H_2O (gaseous) consist of two o's, with two h's attached to one of them and two other h's to the other; the h's of each o getting as near to the other o as the mutual repulsion of the h's allows. Models of

this configuration and of the modification which it experiences in the formation of ice-crystals were shown; also of right- and left-handed quartz molecules and rock-crystal. The crystalline molecule of quartz is supposed to consist of three of the chemical molecules (OSiO). Mr E. Rutherford exhibited, by a number of interesting experiments, a method of detecting electro-magnetic waves. The detector consists of a group of fine steel wires about 1 cm. long, insulated from each other by shellac. These are first magnetised, and then inserted in a coil of many turns of wire provided with a suspended magnet and mirror. The passage of Hertzian waves alters the magnetism of the group of magnets, and shifts the position of the spot of light. For long waves the detector is very sensitive, and has been found to respond to waves produced half a mile away (with houses between); but for short waves a coherer is much more sensitive. The method has been used for measuring the resistance of a spark-gap: for short sparks this is very slight, but increases much more rapidly than the length of the gap. The apparent resistance of iron wires to Hertzian waves is found to be from 10 to 100 times that for steady currents. Prof. J. Chunder Bose exhibited a very neat and compact apparatus for studying the properties of electric waves. With this he has verified the laws of reflection and refraction, determined refractive indices and wave-lengths (by curved gratings), and exhibited polarisation and double refraction by pressure and unequal heating. The gratings used consist of tinfoil strips on ebonite. Between crossed gratings tourmaline exhibits little or no depolarising effect; the difference of transparency for the two vibrations at right angles is nothing like what it is for light. Very good depolarisation is produced by beryl and by serpentine; the latter makes a good electrical tourmaline. So also does a block of jute compressed by hydraulic pressure. Vegetable fibres and locks of human hair produce very striking polarisation effects, the vibrations along the fibres being absorbed, and those at right angles transmitted.

Department II. met in the Physics class-room to consider reports and papers on Meteorology. Reports of four Committees were submitted: on Meteorological Observations on Ben Nevis; on Solar Radiation; on Seismological Observations; and on Meteorological Photographs. Mr. A. W. Clayden's report on the application of photography to the elucidation of meteorological phenomena stated that the work of the Committee during the past year had been almost entirely confined to the determination of cloud altitudes by the photographic method. The two observing cameras are stationed 200 yards apart, and are electrically connected by telegraph wires. Exposures of quarter of a second and less are used. Each negative contains an image of the sun. The altitude and azimuth of this are first determined, and the coordinates of a selected point in the cloud-image are measured with reference to this. Among the greatest altitudes measured are the following (in miles):—Mackerel sky, 7·25; cirro-stratus, 9·63; cirrus, 11·62; upper level cirrus, 17·02. The results show that clouds forming exhibit a general tendency to rise, and this is also true of the ascent of general cloud-levels towards the early afternoon. Papers were read by Prof. Rambaut, on the effect of refraction on the diurnal movement of stars, and a method of allowing for it in astronomical photography; by Mr. G. H. Bryan, on the sailing flight of birds; by the Rev. R. Harley, on the Stanhope arithmetical machine of 1780; and by Mr. A. L. Rotch, on the exploration of the upper air by means of kites.

In the adjourned discussion on Prof. Bose's paper, on Tuesday, Prof. Oliver Lodge exhibited the coherer, "copper hat," &c., which he had used in studying electric waves some three years ago. He characterised his apparatus as being rather unmanageable and very cumbersome as compared with that of Prof. Bose; but members who were present at the Oxford meeting will remember with gratitude Prof. Lodge's interesting address, and the very successful experiments with which it was illustrated. Mr. W. H. Preece made a brief statement as to telegraphy by Hertzian vibrations. Signals have been transmitted (by Signor Marconi, working with Mr. Kempe) across a distance of one and a quarter miles on Salisbury Plain; further experiments are to be made on the Welsh hills. Reports were submitted by the Committee on Electrolysis and the Electrical Standards Committee. At the Ipswich meeting (see Nature, September 26, 1895) the choice of a thermal unit was referred to this Committee, which has since communicated with physicists in various foreign countries on the matter. For many purposes heat is most conveniently measured in ergs. The name Joule has been given to 10^7 ergs. A certain number of Joules may be selected as a secondary or practical thermal unit, and called a Calorie. According to the best determinations made, 4·2 Joules are required to raise the temperature of 1 gm. of water from 9°·5 C. to 10°·5 C., measured by a hydrogen thermometer. The Committee recommend that this be adopted as the secondary thermal unit. More accurate determinations of J, and of the variations of the specific heat of water, may necessitate a slight alteration in the mean temperature at which the rise of 1° takes place; but the definitions and the number (4·2) of Joules in a Calorie would otherwise remain unaltered. It is now proposed to issue a circular requesting international co-operation and agreement. Mr. W. N. Shaw read a paper on the total heat of water. Rowland's measurements give us data for finding the specific heat of water from 0° to 35°; and his measurements, together with those of Regnault, enable us to calculate it from 100° to 180°. What is now needed is a series of determinations from 35° to 100°. Mr. E. H. Griffiths exhibited a special form of resistance box (which admits of easy recalibration of all the coils in the box without requiring any other special instruments), and briefly communicated the results of his measurements of electrical resistance. It is of extreme importance that no shoulders should form on the brass plugs. Standard coils of the B.A. pattern (with wires imbedded in paraffin) only acquire the temperature of the surrounding medium very slowly; it is impossible to make accurate determinations with them when the temperature of the room differs from that of the bath by more than the fraction of a degree. In Mr. Griffiths' box all the coils are of naked wire wound on mica, and immersed in a hydrocarbon oil which is stirred from the outside. Mr. S. A. Sworn communicated the results of long and careful researches on absolute mercurial thermometry, and emphasised the importance of capillary corrections.

On Wednesday the Section again divided into two departments. In the Physics class-room the Report of the Committee on the sizes of pages of periodicals was presented, and papers were read by Mr. W. H. Preece, on disturbance in submarine cables; by Mr. W. M. Mordey, on carbon megohms for high voltages, and on an instrument for measuring magnetic permeability; by Mr. A. P. Trotter, on a direct-reading form of Wheatstone Bridge; and by Prof. F. Bedell, on the division of an alternating current in parallel circuits with mutual induction.

In the Physics Theatre Prof. J. E. Keeler described his method of measurements of the velocity of rotation of the planets by the spectroscopic method. Profs. Elster and Geitel described their investigations as to the cause of the surface colourisation of colourless salts (KCl, NaCl) by the kathode rays discovered by Goldstein. In this process the inside of the exhausted tube becomes coated with a layer which looks as if it might be metallic potassium or sodium. If so, it should be incapable of retaining a negative charge under the influence of violet light; this was tried, and found to be the case. In the case of rubidium and cæsium, gas-light was enough to cause leakage. But Goldstein finds that the salts retain their superficial tints in air for months; so the effect can scarcely be due to free alkali-metals on the surface. Probably the molecules of the metal are driven by the kathode rays into the salt, forming a solid solution in van 't Hoff's sense. It has been shown that the salts become alkaline after kathodic radiation, and this indicates that chlorine has been driven off. No chemical test has shown the presence of free chlorine; but this is not surprising when we consider the difficulty of proving its presence after light has acted upon silver chloride. A paper by Mr. J. Burke, on change of absorption accompanying fluorescence, dealt with a number of experiments made with the view of detecting whether the coefficients of absorption of uranium glass, and some other substances for the rays they emit, are altered in the act of fluorescence. The experiments, which were described at length, showed that a marked difference existed in the two cases, the absorption being greater when fluorescing and when not. Comparisons were made photographically as well as photometrically. Mr. W. Barlow read a paper on homogeneous structures and the symmetrical partitioning of them, with application to crystals.

The interest of the sectional meetings was much enhanced by the discussions following the papers, in which the President, Lord Kelvin, Sir George Stokes, and Prof. G. F. Fitzgerald frequently took part. So also did Prof. Oliver Lodge, who placed at the disposal of the Section all the conveniences of his lecture-rooms and laboratories, and also attended to the comfort and convenience of members in other ways.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—By the resignation of Dr. A. Sheridan Lea, F.R.S., the University Lectureship in Chemical Physiology is vacant. Candidates are instructed to send in their applications to the Vice-Chancellor not later than October 19.

Mr. W. T. N. Spivey, of Trinity College, has been appointed Jacksonian Demonstrator of Organic Chemistry, in succession to Dr. A. Scott; and Mr. Stanley Dunkerley has been appointed Demonstrator in Mechanism and Applied Mechanics, in the place of Mr. Dalby.

The following candidates have passed the Examination in the Science and Art of Agriculture, and are entitled to receive the University Diploma:—W. Burkitt, T. R Robinson (Downing), J. T. Smith (Downing), J. P. Wilton.

The King of the Belgians has presented to the Museum of Zoology a series of casts from the famous Wealden *Iguanodon bernissartensis* preserved in the Royal Museum of Natural History at Brussels, constituting an entire skeleton. This has been mounted in the Comparative Anatomy Lecture Theatre, standing erect; it measures 15½ feet in height, and over 23 feet horizontally. The group of *Dinosauria* has hitherto been unrepresented in the Cambridge Museum.

The election to the Professorship of Surgery, vacant by the death of Sir George Murray Humphry, has been postponed till after the middle of the term. This will enable new arrangements to be made as to the tenure and the emoluments of the chair. Dr. Joseph Griffiths is to carry on the official duties of the Professorship in the interval.

THE London School of Medicine for Women has received a gift of £1000 from a lady who a short time since attended as a student some of the classes held in the school. The interest on this sum is to be divided between bursaries to promising students, and an annual contribution to the library and common room funds. The Helen Prideaux prize, value £50, has been awarded to Miss Edith Knight, M.B. (London), for an essay on the Pseudo-Bacillus of Diphtheria, and its relations to the Klebs-Lœffler Bacillus. The research work upon which the essay is based was carried on in the laboratory of the Institute of Preventive Medicine, Great Russell Street.

FOR the following announcements of extended opportunities for scientific work in America, we are indebted to *Science*:—Mrs. Edward Roby, Mr. E. A. Shedd and Mr. C. B. Shedd have offered the University of Chicago a large tract of land around Wolf Lake and the channel connecting it with Lake Michigan, for the purpose of a lake biological station, and it is also understood that they will erect the buildings for the purpose if the offer is accepted. The gift is valued at £100,000.—The Lewis Institute, the new Chicago school of technology, the foundation-stone of which was laid two years ago, has now been dedicated. The late Allan C. Lewis left, in 1877, £100,000 for the purpose, which has now accumulated so as to make the value of the endowment £333,000—The Ohio State University is now erecting two new buildings, viz. Townshend Hall, for the accommodation of agriculture and agricultural chemistry, to cost £15,000; and a hall for physiology, zoology, and entomology, to cost £7000.

THE following are among the entrance scholarships in science awarded at the London Medical Schools:—Guy's Hospital Medical School: Myers Coplans, scholarship £150; John Ford Northcott, scholarship £60. London Hospital Medical College: Epsom Scholarship, £126, Mr. E. F. Fisher; Price Scholarship in Science, £120, Mr. H. E. Ridewood; Entrance Science Scholarship, £60, Mr. A. B. Lindesey; Entrance Science Scholarship, £35, Mr. C. E. Ham; Price Scholarship in Anatomy and Physiology, open to students of the Universities of Oxford or Cambridge, £60, Mr. E. W. A. Walker. St. Mary's Hospital Medical School—Natural Science Scholarships: £105, Mr. C. C. C. Shaw; £52 10*s*., Mr. W. J. Morrish; £52 10*s*., Mr. J. Gay-French; University Scholarship, £52 10*s*., Mr. A. G. Witson. St. Thomas's Hospital—Entrance Scholarships in Natural Science: £150, Alfred Barton Lindsey; £60, Robert Ellis Roberts; Entrance Scholarship for University Students, £50, Mr. Raymond J. Horton Smith, of St. John's College, Cambridge.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 28.—M. A. Cornu in the chair.—Cryoscopy of precision; application to solutions of sodium chloride, by M. F. M. Raoult. The data given for weak solutions of common salt show that the expression previously proposed by the author, $C_1 = C_0(1 + q)$, where C_1 is the apparent lowering of the freezing-point, C_0 the true lowering, and q a very small constant (·002), holds within the limits of experimental error. The criticism of this expression by M. Ponsot is thus shown to be incorrect.—Observations of the Brooks comet (September 4), made with the Brunner equatorial, and of the Giacobini comet, made also with the large Gautier telescope at the Observatory of Toulouse, by M. F. Rossard.—Observations of the Giacobini comet (September 4), made at the Observatory of Lyons, by M. G. Le Cadet.—Solar observations made at the Observatory of Lyons during the third quarter of 1896, by M. J. Guillaume.—Sun-spots in relation to time, by M. Marcel Brillouin.—On the laws of reciprocity, by M. X. Stouff.—On the distribution of deformations in metals submitted to strain, by M. G. Charpy. A reply to a paper on the same subject, by M. Hartmann.—On the absorption of ultra-violet light by crystallised bodies, by M. V. Agafonoff.—On a spectrum from the kathode rays, by M. Birkeland.—On the existence of acid properties of nickel dioxide, by M. E. Dufau.—Researches on double bromides, by M. R. Varet.—On the immunity conferred by some anti-coagulating substances, by MM. Bosc and Delezenne.—On the presence of the agglutinating property in the plasma, and other liquids from the organism, by MM. Ch. Achard and R. Bensaude.—Influence of rest, physical exercise, intellectual work, and the emotions upon the capillary circulation in man, by MM. A. Binet and J. Courtier.—On the structure of the body-wall of Plathelminthus parasites, by M. Léon Jammes.—On the existence of "epitoque" forms in Annelids, by MM. F. Mesnil and Caullery.—Experiment establishing the preservation of venomous properties of the venom of serpents, by M. P. Maisonneuve.—On the results of researches on mineral coal recently made in Siberia, by M. Venukoff.

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THURSDAY, OCTOBER 15, 1896.

THE BERTILLON SYSTEM OF IDENTIFICATION

Signaletic Instructions, including the Theory and Practice of Anthropometrical Identification. By Alphonse Bertillon. Translated from the latest French edition. Edited under the supervision of Major R. W. McClaughry. Pp. xx + 260, and plates. (Chicago: The Werner Company. London: Kegan Paul and Co., Ltd., 1896.)

THERE is much that is both interesting and instructive in Major R. W. McClaughry's translation of Bertillon's last book of 1893; for it contains an account, revised up to date, by M. Bertillon himself, of the system as at present in work in Paris. Its contents may conveniently be divided into three parts: *first*, the anthropometric definition of individuals, whereby what may be called a *natural name* is given to each person measured, based upon five principal measures (but there is some want of definiteness about this), which can be classified and looked for, just as a real name is classified and can be looked for in an alphabetical directory. There are, of course, many persons who have the same "natural" names, just as there are many Smiths; still, the knowledge that the name of a person is Smith, is a very important help to further differentiation. The *second* portion is of a hybrid character, partly subserving the same purpose as the first, to an extent and in a way that is not clearly described, and partly as affording particulars whereby it may be positively affirmed whether any, and, if any, which, of all the "Smiths" is the right man. This second portion includes photographs and the verbal descriptions briefly worded or symbolised, of a great variety of personal characteristics, as of forehead, nose, chin, hair, eyes, ear, eye brows and lids, mouth, wrinkles, &c., and finally of cicatrices and body-marks. It is not clearly stated how much of all this is generally entered on a prisoner's card; but the total entries on the specimen signaletic card (Plate 78) contains, as well as I can count them, 12 measures, 58 separate details in a sort of shorthand, and 193 facts concerning marks and scars, also in shorthand, so that the whole of this extraordinarily complex description, containing some separate 263 notations, packs into small space. The *third* portion somewhat trenches on the second, as the second did upon the first. It endeavours to show how a verbal portrait may be built up out of specified materials. Let us say, for brevity—forehead No. 3, nose No. 4, lips No. 1, and so on, and there you have the picture. It is, at all events, an amusing game to try how far, with a box of specimens, like a kindergarten box, a recognisable face might be built up. I would suggest that toy manufacturers should study this part of the book, and bring out a box in time for the forthcoming Christmas parties.

As said already, it is difficult to gather how far this enormous amount of labour is bestowed upon each prisoner; in any case, the success of the Paris *bureau* is certainly very great. It has the peculiar advantage of being worked under special conditions, all prisoners being taken to the same measuring-place, where numerous clerks, under careful inspection, working day by day, have acquired a remarkable degree of sureness and deftness in their work.

The modern French system of giving what is described above as "natural names," differs from the modern English in that it as yet attempts no *classification* by finger-prints. In the English plan a primary subdivision of the cards is made on the first of the above methods, using five measures, and these subdivisions are themselves to be subdivided by classifying the finger-prints. It is to be regretted that the volume under review takes but scant and imperfect notice of the now pretty widely-known method of finger-prints, which in my own, perhaps prejudiced, opinion is far more efficient for classification, and incomparably more so for final identification, than the whole of the second of the above portions, while the finger-prints are much more surely and quickly put upon paper than they are. They afford, moreover, the only means of surely identifying growing youths. It is true that the prints of the thumb and three fingers of the right-hand are at length introduced into M. Bertillon's cards, as shown in the specimen (Plate 79*a*), but there is a regrettable error in the date of the circular (p. 259) drawing attention to the innovation. The date is entered as 1884, and not as 1894, as it should have been (see note, p. 14), and conveys the idea that the use of finger-prints in Paris is much older than it really is, and previous, instead of subsequent, to its use in England.

The practical question arises as to how far the method of M. Bertillon is suitable for adoption in its entirety, or otherwise, in other countries than France. The publishers of this volume state, in a preface, that it is in use "to some extent" in about twenty prisons and seven police departments in the United States. Mr. Bertillon says: "The countries which at the present time have officially adopted the system of anthropological identification are the United States, Belgium, Switzerland, Prussia, most of the Republics of South America, Tunis, British India, Roumania," &c.

I fear the words "to some extent" must be emphatically applied to many of these, besides the United States. So far as I can hear, the only Presidency in British India that has officially taken up the system is Bengal, where it has "to some extent" been on trial for some years and with considerable success, under the condition of a more laborious system of inspection than can easily be maintained. I will quote what is doing there now from the latest circular of Mr. E. R. Henry, Inspector-General of Police, dated Calcutta, January 11, 1896.

"The weaknesses of the anthropometric system are well known. Notwithstanding the improvements introduced, the error due to the personal equation of the measurer cannot be wholly eliminated, and as hundreds of measurers have to be employed, it is inevitable that errors due to careless measuring and to incorrect reading and description of results should occasionally occur. A system based on finger impressions would be free from these inherent defects of the anthropometric system, and for its full and effective utilisation it would only be necessary to take the impressions with the amount of care needed to ensure that the prints are not blurred. It may be added that a considerable gain as regards time would result from the change of system, there being no difficulty in taking the impressions of the fingers of half-a-dozen persons in less than the time required to complete the measurements of one."

B B

"At present a duplicate Criminal Record is being kept, *i.e.* a record based on anthropometric measurements *plus* thumb-marks, and also separately a record based solely on the impressions of the ten digits. A system of classifying the latter is being worked out, and if after being subjected to severe tests it is found to yield sufficient power of differentiation to enable search to be unerringly made, it seems probable that measurements will gradually be abandoned as data for fixing identity, dependence being placed exclusively upon finger impressions."

It seems, therefore, that the following phrase of M. Bertillon requires modification: "We may safely say, then, of this new edition, that it is final in its main outlines and in most of its details, and that any future edition, if such there should be, will differ from it very little." A perfect system is one that attains its end with the minimum of effort, and that certainly cannot be affirmed of the French system. In my own opinion, the present English system (which includes full-face and profile photographs) much more nearly fulfils that definition.

FRANCIS GALTON.

SCIENCE AND THEOLOGY.

A History of the Warfare of Science with Theology in Christendom. By Andrew Dickson White, LL.D., &c., late President and Professor of History at Cornell University. 2 vols. Pp. xxiv + 416, xiv + 474. (London: Macmillan and Co., 1896.)

TWENTY years ago Dr. White published a little volume, entitled the "Warfare of Science," to which the late Prof. Tyndall contributed a brief preface. Out of that volume has grown the present book, which, though very much more learned, has lost something of the freshness that characterised its predecessor. We should like to have said that the one had made the other needless, but, as ecclesiastical dignitaries still accept men like Dr. Kinns for authorities in science and champions of orthodoxy, we fear that Giant Pope—using the title in a wider sense than Bunyan did—is hardly dead yet. This book is melancholy reading, for it tells, again and again, of the miserable mistakes that have been made by good men with the very best intentions. Here and there, perhaps, Dr. White a little magnifies these mistakes and overlooks extenuating circumstances; is, perhaps, a little too ready to accept witnesses on his own side, as when he assumes it proved that man existed on the Pacific slope of America in the Pliocene age. The acute theologian also might sometimes have his chances of breaking the windows in the house of the man of science, for the latter occasionally talks wildly when he trespasses on the other's province. But we must sorrowfully admit, that Churchmen and Nonconformists alike—the most extreme Protestants as well as the most ardent Romanists—have distinguished themselves too often by their unwise and ignorant opposition to scientific facts and scientific progress. The former adversaries have not been less illiberal than the latter; indeed, of late years they have perhaps been more so. They have not persecuted so actively, simply because they have not so often had the power; as to the will, the less said the better.

Dr. White discusses the various branches of his subject in separate chapters. The first, entitled "From Creation to Evolution," is not the least interesting, though we think that in these words he needlessly gives a point to an assailant; for to a theist evolution might appear only a mode of creation. But special creation is obviously meant, so that we may pass on. This chapter gives a very interesting summary of opinion, ancient and modern, ending with the story of the storm raised by the publication of Darwin's "Origin of Species." Here, as in several other places, Dr. White's book is of great though indirect value, because of its plain speaking. The spirit of saint worship lingers in most religious bodies. It is deemed almost profane to admit that good and well-meaning men could make great mistakes, and thus produce serious mischief; could use absurd arguments, utter intemperate language, and do unjust actions. But Dr. White is no believer in this policy. Bishop Wilberforce of Oxford, even Pusey and Liddon, with firebrands like Dean Burgon and Archdeacon Denison, are dealt with in a spirit of refreshing candour; and even Mr. Gladstone occasionally comes in for not unkindly criticism, though his courtesy to theological antagonists receives its due meed of praise.

Then the author passes on to geography, with the absurd figments of Cosmas Indicopleustes and that deadly heresy of the existence of the antipodes; to astronomy, with the denunciation of the heliocentric theory of the planetary system, and the story of Galileo. Next we come to the battles over geology, the antiquity of man, anthropology, and the discoveries in Egyptian and Chaldæan history. Magic and demonology, with the development of chemistry and physics, follow next, together with the spread of scientific views on medicine and hygiene. Here theologians are charged with having opposed inoculation, vaccination, and the use of anæsthetics. As regards the second, they might now retort that its present opponents, as a body, are not specially distinguished either for orthodoxy or for religious zeal. Next come chapters on lunacy and demoniacal possession, a subject more difficult than appears on the surface, and concerning which, we may be sure, the last word has not yet been said. After chapters on the origin of language and the Dead Sea legends, the book concludes with a sketch of the development of modern ideas as to the function of inspiration and the duty of criticism.

Dr. White's book is a very exhaustive survey of this unreasonable conflict, which we may hope is coming to an end, and will be valuable as a work of reference. It should be carefully studied by all tutors in theological colleges, who would do well to give the substance of it in lectures to students preparing for the ministry, lest perchance they make the same mistakes as did their forefathers.

T. G. B.

OUR BOOK SHELF.

A Manual of Botany. By J. Reynolds Green, Sc.D., F.R.S., F.Z.S., Professor of Botany to the Pharmaceutical Society of Great Britain. Vol. ii. Classification and Physiology. (London: J. and A. Churchill, 1896.)

THE second volume of Prof. Green's "Manual of Botany" concludes a work, the usefulness of which will be recognised by students and teachers alike. The present part is devoted to the treatment of taxonomy and physiology, and opens with an account of the general principles of classification, and of the leading systems which have severally left their mark on the progress of the science.

It is not possible, within the narrow limits of a small text-book, to present an adequate picture of the tribes and orders of the Cryptogams, and this is especially true for the Algæ and Fungi. Hence the treatment accorded to the last-mentioned groups is of necessity somewhat sketchy. But, nevertheless, the author has managed to include a considerable amount of the most important information respecting them, illustrated in many cases by copies of Kny's admirable *Wandtafeln*. We notice, however, that the familiar drawing, after Sachs, of the structure of the mushroom is reproduced, in which the basidia are represented as bearing only two spores, although in the text the normal number is correctly given as four. It seems high time that this figure disappeared from our text-books; its chief function at present is to show how difficult a matter it is to get rid of a fiction which has once managed to pass itself off as a genuine fact. Whilst we are on the subject of illustrations, we cannot forbear to remark on the surprising group of Moss-antheridia represented in Fig. 860. No doubt in future editions the author will replace this by a more adequate drawing. Both the Vascular Cryptogams and the Angiosperms are, on the whole, admirably treated, but the Gymnosperms hardly receive the recognition due to their important position; we venture to think that the artificial key on p. 180 might well have been omitted.

In dealing with the Phanerogams the classification of Bentham and Hooker is adhered to, and much valuable information is given as to the uses and geographical distribution of the plants comprised in the various Orders.

But it is the physiological part of the book which impresses us most favourably. The student will find the most important facts and principles of this branch of the science most clearly and suggestively put before him. Nutrition is especially well handled; and it is not necessary to add that the chapters on reserve materials and ferments form a most valuable epitome of our knowledge respecting them, since the author is well known as a distinguished investigator in connection with these matters.

The book is, altogether, one of the best of our English intermediate text-books, and it is certainly one which no student ought to neglect.

Wool Dyeing. Part i. By Walter M. Gardner, F.C.S. Pp. 108. (Manchester: John Heywood.)

This little book is a reprint of a series of articles contributed to the *Textile Recorder*. In spite of the title, the subject of dyeing is not dealt with, being reserved for parts ii. and iii., and only the operations previous to dyeing are treated of in the present volume. The divisions of this subject are: (1) The Wool Fibre; (2) Wool Scouring; (3) Wool Bleaching; (4) Water for Technical Purposes. The treatment, although not exhaustive, is fairly thorough and quite up-to-date, and no important feature of these subjects, either chemical or mechanical, is left untouched. The book can hardly be described as attractive reading for an outsider; but it will doubtless prove useful to teachers and students in technical classes, and should be helpful also to those engaged in the dyeing industry—happily a growing number—who wish to understand the principles underlying the operations they conduct, and who may be led by it to the study of some more exhaustive work.

It is to be regretted that in appearance the book is hardly worthy of its subject-matter; the paper employed has a very uninviting aspect, and the few illustrations are of little value. This being the case, we must demur at the author's claim to cheapness. One more complaint: to those whose chemical knowledge is but slight, one or two misprints may cause perplexity, and we can imagine a student inquiring in bewilderment why the hardness of water should be expressed in terms of the $CaCO_1$ (*sic*) contained therein.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* Nature. *No notice is taken of anonymous communications.*]

Osmotic Pressure.

In the October number of the *Philosophical Magazine* will be found an interesting paper, by Prof. Poynting, which explains the phenomena of the osmotic pressure of solutions by the hypothesis of chemical combination between the solvent and the dissolved matter. I wish to direct the attention of your readers to one point in the paper, and to a development of it which seems to me to be worthy of notice. Any successful theory of solution must explain the fact that the osmotic pressure obeys the usual laws of gaseous pressure—those of Boyle and Avogadro—and, moreover, has the same absolute value as that of the pressure which the dissolved molecules would exert in the gaseous state, when filling a volume equal to that of the solution. It has always been clear that, whatever be the ultimate cause of the osmotic pressure, the gaseous laws must be obeyed by dilute solutions. The molecules of any finely-divided matter must be, in general, out of each other's sphere of influence, so that each will produce its effect independently of the rest. But this is all that is necessary for Boyle's law and Avogadro's law to hold, so that these, as well as the mere existence of osmotic pressure, are explained by chemical combination just as well as by molecular bombardment. On the other hand, no good reason has been hitherto given why chemical forces should be so adjusted that the osmotic pressure of the dissolved molecules should have the same absolute value as that of the pressure which the same number of gaseous molecules would exert when filling an equal volume.

Prof. Poynting supposes that each molecule of dissolved matter combines with the solvent to form unstable compounds, which continually exchange constituents. The molecules of solvent thus combined will be less energetic than the molecules of pure solvent, and thus may be unable to evaporate. Nevertheless, since they are always being liberated and re-combined, they will still be effective in retaining molecules of vapour condensing on the surface. The vapour pressure will, therefore, be reduced, and it follows that, if we make the additional assumption that one molecule of the dissolved substance unites with one molecule of the solvent, the fractional diminution of vapour pressure will be the same as that calculated from the osmotic pressure given by Van 't Hoff's law. We can, of course, working backward from this result, show that the osmotic pressure will have the gaseous value. If one dissolved molecule combines with two or three solvent molecules, the osmotic pressure would have double or treble its normal value. Although he does not explicitly say so, I fancy that Prof. Poynting means to suggest this as a cause of the abnormally great osmotic pressures shown by solutions of metallic salts and other electrolytes, and thus to do away with what he calls "the difficulties of the dissociation hypothesis."

Now the evidence in favour of the view that the opposite ions of an electrolyte are dissociated from *each other* is enormously strong, though there is no reason to suppose that the ions are not united to the solvent. Some of the chief points in favour of their freedom may shortly be summarised as follows: (1) The fact that the electrical conductivity of a dilute solution is proportional to its concentration; whereas, if the ions moved forward by taking advantage of collisions between the dissolved molecules and consequent rearrangements, it would vary as some power of the concentration higher than the first. (2) The confirmation of the values given by Kohlrausch as the specific velocities of the ions, the velocity of each ion being, in dilute solution, independent of the nature of the other ion present. (3) The successful calculation by Nernst and Planck of the coefficients of diffusion of electrolytes, and of the contact differences of potential between their solutions on the hypothesis that the ions migrate independently of each other.

Thus we cannot lightly give up the idea that the ions are free from each other, and it seems to me that a very simple extension of Prof. Poynting's theory will enable us to retain that view.

We have only to suppose that, in the case of electrolytes, the dissolved molecules are resolved into their ions, and that each ion so produced unites with one solvent molecule, or, at all events, destroys the mobility of one solvent molecule. A simple

compound like NaCl, which is decomposed into two ions $\overset{+}{Na}$ and $\overset{-}{Cl}$, will thus produce double the normal effect on the osmotic pressure and its consequences the diminution of vapour pressure and the lowering of the freezing point. In the same way, a molecule like H_2SO_4, which gives three ions, will produce three times the effect which would be obtained if it were undissociated.

Thus Prof. Poynting's conditions would be satisfied, and at the same time the advantages of the dissociation theory would be retained. W. C. D. Whetham.

Trinity College, Cambridge, October 12.

Responsibility in Science.

As one who supposes himself a physicist, I wish to protest against some of Prof. Poulton's remarks in his recent British Association address, as given in Nature, September 24.

From the statements on p. 502, one would suppose that physicists as a body had long been tyrannising over geologists and zoologists, and that this reign of terror had remained unbroken until recently, save for some slight diversions afforded by mathematicians.

When it comes to details, the physicists seem to resolve themselves into two individuals, Lord Kelvin and Prof. Tait, and perhaps a third, von Helmholtz; all of whom, by the way, have an equally good claim to the title mathematician. Prof. Poulton apparently regards all physicists as committed to every theory propounded by every individual physicist. This would certainly be unlimited liability with a vengeance.

Personally I do not hold myself committed to the truth of any theory, past, present, or future, until such time as I have explicitly signified my assent to it. If one were explicitly to signify one's dissent from every physical theory, or every statement of physical facts, which one is not prepared to accept, there might be little time left to do anything else. Perhaps I can bring this home most clearly to Prof. Poulton by expressing my views as to one or two of his own statements.

On page 502 he says, "the earth, even when solid, will alter its form when exposed *for a long time* to the action of *great* forces" (italics mine). Here, and in the rest of the passage, is a strong flavour of the erroneous view that a solid is *rigid* in the mathematical sense, except when viscous under great and prolonged stress. It is surely time that scientific men in all departments grasped the conception of elastic strain and displacement.

On the same page are other imperfections in the statement of the arguments against deducing the time of consolidation of the earth from its present form. Prof. Poulton apparently considers it proved that the earth's angular velocity of rotation is diminishing, and that the only agent to be considered is the action of the tides. If, however, the earth's temperature is diminishing, and the material contracts in cooling—conclusions most generally accepted—the consequent diminution in the moment of inertia tends to *shorten* the period of rotation. Such shortening was in fact made the basis of his speculations by the eminent French mathematician Prof. E. Roche (Académie . . . de Montpellier, *Mémoires de la Section des Sciences*, vol. x., 1880–84, p. 232).

On page 503, we are told "there is some evidence which indicates that the interior of the earth in all probability conducts better than the surface Its far higher density is consistent with the belief that it is rich in metals, free or combined. Prof. Schuster concludes that the internal electric conductivity must be considerably greater than the external."

When one considers the enormous pressures which existing theories point to in the earth's interior, and remembers how conspicuously less the accepted mean density is than that of the lightest of the heavy metals under atmospheric pressure, one can only recognise the inconclusiveness of the evidence from this source.

The reference to Prof. Schuster's conclusion is ambiguous. Does Prof. Poulton believe electrical and thermal conductivity necessarily to vary together? If so, then the fact that electrical conductivity diminishes in metals and ordinary alloys as the temperature rises, is one he ought to consider. In any case he might be well advised to allow for the possibility that Lord Kelvin's speculations do not possess a monopoly of physical uncertainties.

The direct experiments by Lord Kelvin (Nature, June 1895, p. 182) on the influence of temperature on thermal conductivity are very probably, in Prof. Poulton's opinion, not sufficiently varied, as regards either material or range of temperature, to form a substantial basis for wide conclusions. Still I should have expected him to refer to them, if only to mark his recognition of an attempt on Lord Kelvin's part to meet his critics with something better than surmises.

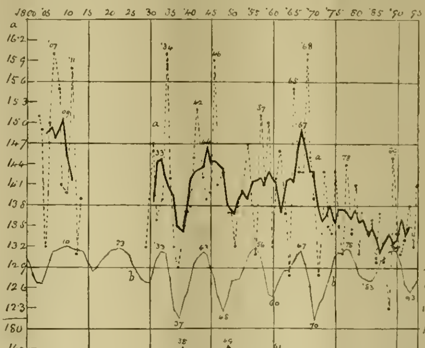
Our uncertainty as to the true value of the mean temperature gradient near the earth's surface might fairly, I think, have been adduced by Prof. Poulton. Observations have, in fact, been limited to comparatively small areas of the surface, and the results obtained have varied much. There are also sources of error whose elimination is difficult. Irregularities in the surface, the presence of the recording apparatus, and the disturbance caused by previous excavations, tend to alter the temperature it is intended to measure; while the conditions may prejudice the correct working of the apparatus. An instructive example of this last defect came under my notice recently. Very fairly accordant readings with two maximum thermometers in a deep boring full of water indicated an excess of some 30° F. in the bottom over the surface temperature. Direct experiment in a hydraulic press proved, however, that fully half the rise was fictitious, being simply due to the contraction of the bulbs under the pressure to which they were exposed. C. Chree.

September 28.

The Climate of Bremen in Relation to Sun-spots.

May I invite attention to the variation of mean temperature of the summer half (April to September) at Bremen, which seems to me to suggest sun-spot influence? The observations used are those given by Dr. Bergholz in his "Ergebnisse." They extend (with a break from 1814 to 1823) from the beginning of the century.

The dotted curve in the diagram (*a*) shows this variation. After smoothing with averages of 5, we have the continuous



a. Dotted curve, mean temperature April to September, Bremen. Continuous curve, smoothed with averages of 5. *b*. Sun-spot curve (inverted). *c*. Smoothed curve of rainfall, August and September, Bremen.

curve traversing the other. Below, (*b*), is the sun-spot curve, *inverted*, and a general agreement will be made out with the aid of the figures given; the wave-crests of the smoothed curve corresponding, more or less, with the minima of sun-spots. This result is in harmony with those of Köppen and others.

We may note the salient years (half-years) 1811, 1834, 1842 (1846), 1857, 1868, 1878, 1889; all near minima.

Representing the half-years as + or −, according as they are above or below the average, and selecting the sun-spot maximum and minimum years, I find five out of seven of those seasons in the former case (maximum) to be *below* average, and four out

of six in the latter case (minimum) *above* average; also including (say) two of the following years in each case, a tendency to excess of − values in one case, and of + values in the other. If the amounts of excess and deficit be further considered, the average deficit in the one case, and excess in the other, is distinctly the greater.

(Two averages have here been used, dividing at 1870.)

We have considered six months of the year. But the same tendency may be discerned in individual months, and other combinations of months. June and August show it very well; also (less distinctly) the whole summer group (June to August).

If any one will take the trouble to compare smoothed curves of June temperature at a number of European stations, he will find, I believe, that most of these agree in the feature considered, and that one supplements another. Thus the correspondence with the sun-spot curve may fail somewhat at a particular point in the case of one station; but another curve agrees better at that point, and so on.

A comparison of six months' curves for other stations seems desirable. The Greenwich curve, I think, shows the influence, but less fully.

In such selections and comparisons of portions of the year and different stations, an analogy might be traced to what occurs in looking at something through a microscope. We screw the tube out and in, and at one point get a generally clear image; with another position, part of the image is blurred and part rendered more distinct; with still another, there is a general blurring, and so on.

The rainfall of Bremen, especially in the summer half, also presents interesting features in this connection (see *Met. Zeits.* for 1895, p 120).

Several of the monthly curves show a tendency to high values near maximum sun-spots. I have here combined the rainfall of August and September in a smoothed curve (*c*). The maxima and minima, it will be seen, correspond pretty closely with those of the sun-spots.

Has not a too mechanical conception regarding sun-spots and weather prevailed in the minds of some? In view of the great instability and variability of weather, is it not rational to suppose that the thing to be looked for may be merely of the nature of an average effect, a tendency, a preponderance? The position, further, that if sun spots affect weather, they must affect it everywhere in the same way, I believe to be untenable.

A. B. M.

An Antidote to Snake-Bites: "Scorpion-Oil."

I came across the following popular remedy last June, when at Kandersteg. Since my return to England I have written to the guide, Abraham Muller, and here give the substance of his answer to my request for more exact details.

Every year Italian scorpion-sellers traverse Switzerland, especially the mountain-valleys thereof; in the lower land and towns the remedy can be obtained at the chemists', and these buy their scorpions direct from Italy. It is usual to take, say, a half-litre of good olive oil (at the time he told me it was walnut oil; perhaps this is commoner and cheaper?), and throw therein about ten living scorpions. The scorpions are left in the oil until they die—say twelve or twenty-four hours. They are then taken out and thrown away, or the oil is poured from off them into a bottle.

In the case of poisonous snake-bites, or poisonous "*Insektenstichen*," the wound is first, if possible, washed out with salt water. The scorpion-oil is then rubbed in, and all round over the swollen part, the rubbing being towards the wound.

In the case of other "*giechtigen*[1] *Schnitten, Stichen, Guetschungen, gichtigen Geschwülste und dergleichen*," the oil is applied in like manner, only it is not poured into the wound, as it is too "*scharpf*."

The custom is centuries old, and (my informant believes) very widely spread in Switzerland. He could find out more details, if required, from a chemist.

In general the application is external only; but there are men who, when suffering from great internal pain of which they do not know the cause, drink some drops of the oil in camomile tea. (Result not stated!)

The scorpion-oil is used for men and animals alike.

It seems to me that, since the oil rubbed into the wound caused by a snake or an insect doubtless contains some scorpion poison, the above is of interest in connection with the recent experiments in inoculation. (Nature, vol. liii. pp. 569, 592)

R.N.E. College, Devonport. W. Larden.

[1] I think that *giechtigen* must be an error for *giftigen*; it cannot well be *gichtigen* when used with *Schnitten*. My knowledge of German does not enable me to translate *Guetschungen* or *Gnetschnngen*. I have given these few words in the German to avoid confusion.

Chameleonic Notes.

Mr. Bartlett writes me that they have no chameleon now in the Gardens, so that probably my little stranger is the only one in this country; and to the note on its habits, which you printed in your number of July 16, may I add the following: Little is known of these most interesting creatures, and the book knowledge is singularly discrepant. After being kept for nearly eight months under a large bell glass in my library, and fed with garden flies of all sorts, he began changing his skin. This, first, appeared to hang rather loosely in *milk-white folds* on his body, then he got rid of it bit by bit, squirming himself against the stick on which he was perched, and continually changing his attitude. He also used his feet *occasionally*, to help to rip off the old skin; and being very restless, this was all got rid of in one day. His general colour also changed from very light brown to very dark brown, then to light brown, and again to very dark brown, while the skin-shedding took place. He never seemed to care for any water all the time I had him. On being approached in a dark room at night, he appeared most conspicuously *white*, doubtless for protective purposes. I believe wild-fowl shooters are also in the habit of painting their boats and paraphernalia white in order to be less conspicuous. Turning the bright light of a lantern (with a powerful reflector) upon him, he immediately began *visibly* to darken, until in an extremely short space of time he had assumed the same colour as the brown twig on which he was sitting. These colour changes have, I think, never been satisfactorily explained; and their *rapidity* is not the least extraordinary phenomenon in these most curious creatures.

E. L. J. Ridsdale.

Visual Aid in the Oral Teaching of Deaf-Mutes.

I must confess to being one of those unacquainted with Kœnig's invention, but the object of the interesting experiment described by Mr. Hawksley in Nature of October 1 is sufficiently evident from the results.

Since the experiments of MM. Marey and Rosapelly, and more recently the phonograph, rendered it possible to reproduce in a graphic form the sounds of the human voice, the question of the practical application of such visual reproductions in the oral education of the deaf has frequently been mooted, but so far without any useful result.

As is well known, the speech of orally educated deaf-mutes is not usually so natural, and hence not so readily understood, as that of those who hear. This is chiefly due to the absence of the controlling action of the hearing; but if this could be supplied by visual means, much might be accomplished.

If, therefore, some physicist would devise a simple and efficient apparatus by which an orally taught deaf-mute could test his speech to ascertain how far it corresponded in inflection, &c., with that of his teacher or other hearing person, and to regulate it accordingly, a great practical boon would be conferred on the deaf and their teachers.

Doubtless, as Mr. Hawksley says, the principle of Kœnig's invention might be made useful to oral teachers, but a simpler application of it than is exhibited in his experiment would be desirable, and indeed necessary, before it could become generally available.

A. Farrar, Jun.

October 2.

A Remarkable Lightning Flash.

The "remarkable lightning flash" depicted by Mr. George G. Burch in Nature for September 24, is to me interesting. Many years ago I witnessed what was probably a flash of the same kind, a phenomenon I considered at the time very extraordinary. In the early evening of a fine summer day, while sitting leisurely on a hedge on a comparatively high hill near to Llandyssul in the county of Cardigan, with an immense area of country within reach of my vision, there appeared, slightly above the horizon in the west, what seemed to be a perfectly endless flash, almost circular in shape, and exceedingly serrated.

There was not a single stray end to be seen, as in Mr. Burch's flash. I heard no thunder, and I knew from the faintness of the

spark that it was at a great distance from me. This flash lasted for a longer time than any one I have seen since. I happened to be gazing at the actual spot when the flash occurred, and I saw it well.

The only explanation I can offer is this: that the spectator is looking along the axis of a spiral-shaped flash; the flash occurring from cloud to cloud. BENJAMIN DAVIES.

Liverpool, October 3.

Distribution of Galeodes.

It seems hardly worth while my interfering in this matter, but as Mr. Pocock, in his note on the distribution of Galeodes, in NATURE of August 20, omits Sind, I hasten to record it from that province, where I have often dug it out of Indus alluvium. I used to think that Galeodes was a desert animal, and was surprised to hear from friends that it is common along the Malabar coast south of Bombay and further inland, where the rainfall is heavy. F. GLEADOW.

Dehra Dún, September 14.

THE RECENT EARTHQUAKES IN ICELAND.

ON August 26, at 10.30 p.m. and next day, at 9.15 a.m., severe earthquake shocks were felt throughout the south-western part of Iceland. The seismic focus seems to have been situated in the neighbourhood of the volcanic ridge out of which Hekla rises, and the waves moved in a direction which they had formerly been observed to take, namely from north-east to south-west. According to reports to hand, these shocks were felt as far north-west as Ísafjord and as far north as the head of Skagafjord. Thus it appears they overran an area of more than 20,000 square miles, or half the island, for they also caused damage in the Westman Islands, which lie further south than the most southern point of Iceland. Even at sea the shock was felt. A sailing ship was so badly shaken, thirty-five miles from land, that the crew feared it had struck a rock, and began to lower the boats.

From this it is clear that these earthquakes spread their waves over an area unprecedented in extent in the history of the island.

After some minor and slighter shocks, the next severe ones occurred on September 5, at 11.30 p.m., and two and a half hours later, in the night, at 2 o'clock. These shocks were fully as violent as the first ones, but they were more local, and the seismic centre from which they proceeded seemed to be further to the south-west than in August. The shocks were preceded by heavy rumbling noises underground. Land-slides came down from the mountain-sides, destroying the green home pastures. Immense rocks were hurled down from their peaks, and the echoes of these convulsions of nature reverberated among the mountains. The turf and stone walls of the Icelandic farmhouses crumbled like card houses, but the people, being warned by the 11.30 shock, saved their lives through doors and windows. While many were bruised and wounded, and some were dug out of the ruins, only two are reported to have been killed. In the August shocks one man was killed in the Westman Islands, being crushed by a rock that tumbled down over a precipice.

While it is calculated that two to three hundred homesteads, each representing five to six houses, have been wholly or partially destroyed, it is singular to note that no timber house has fallen down, though some of them were actually moved out of their position. The inhabitants have since September 5 camped out, as best they could, in improvised tents and huts.

The violent vibrations in the crust of the earth have torn it open in places. Deep chasms yawn where the ground has been burst open, and a number of fissures have been formed. The largest of these is situated close by the Oelvus River, on its western bank. It is about six miles in length, but neither very broad nor deep, and half-filled with water.

Still more noteworthy than these longitudinal cracks in the ground are the new geysers, which have forced their way into the open. Some of the old hot springs have disappeared, and been displaced along with the stratum through which they issued. Of the new geysers, information has been gathered about three at the farm Hveragerthi, west of the Oelvus River, and one at Reykir. The largest of those at Hveragerthi has a basin measuring fifty-four feet by twenty-four feet. Its depth has not been ascertained. The column of boiling water rose at first thirty to forty feet into the air; but, according to the latest reports, its height is decreasing. The people of the two farms say that the crash, when the column of water first broke the earth crust open, was terrific and deafening.

Many other changes took place in the surface of the ground. High ground subsided, and became wet instead of dry. Low, miry ground became hard. In brooks and lakelets the water grew yellow and turbid. In fact, the whole appearance of the districts affected by these earthquakes has undergone a noticeable transformation.

The intensity of the vibrations caused by the shocks was greatest in the neighbourhood of the Oelvus River. Persons standing on level ground could not keep their feet. A farmer was literally thrown out of his bed on to the floor. The duration of each shock was from thirty to fifty seconds; in some cases less, but none of them seem to have lasted a whole minute, though the time appeared to be much longer than that to the frightened farm people waiting in anxious suspense for the fate of their houses.

No earthquakes comparable to these have occurred in Iceland, save in 1784. The severest shocks then took place on August 14 and 16, but were confined to a much more restricted area than the present ones, an area reaching farther north-east and less south-west than in 1896. These earthquakes lasted from the middle of August till December of the same year, and caused great damage to farmhouses, sixty-nine of which were totally broken down, while 372 were made almost uninhabitable. These earthquakes must, it is thought, have stood in some connection with the volcanic eruptions close to the glacier-covered volcano Skaptarjökul, which lasted on, with short breaks, from June 1783 to January 1784. The Icelanders draw the inference that earthquakes must be preceded, accompanied, or followed by eruptions. One glance at Thoroddsen's history of eruptions and earthquakes suffices, however, to disprove this popular fallacy. It is feared that the earthquakes will continue for months, unless the subterraneous fire breaks out and puts an end to them. One hears the natives earnestly wishing for an eruption ("eldgos," *i.e.* fire-spouting). Meanwhile they have saved all their cattle, with few exceptions, and wish to rebuild their farms.

The last news from Iceland is of date September 19. Slight shocks were felt from time to time. The severest of these was one on September 10, at 11.20 a.m. New fissures appeared in the ground, while some of those already formed were widened. Strange subterraneous noises resembling thunder have been heard, sometimes unaccompanied by shocks. To all appearances the earthquakes are not over yet, though it is to be hoped, for the sake of the suffering people in the districts of Rangarvalla and Árnes-sýsla, that the worst is past.

Some money has been subscribed, and the Government will contribute to the funds thus raised. The Czar has given £160, the Dowager Empress of Russia £100, and the King of Denmark and his family the same amount. The sympathy of Europe has been aroused for the brave people struggling for their existence amid frost and fire on the verge of the habitable world.

It has been stated that there are over 700 extinct craters

in the peninsula of Reykjanes alone. The capital is situated on its northern side, and thus only fifty to sixty miles from the devastated districts. Some of the inhabitants of the town camped out, but none of its houses, which are mostly of timber, collapsed. The pictures hanging in the Parliament House were all thrown out of position, and rifts were visible in the plastered ceiling.

The eruption of February 27, 1878, is the last one recorded in the vicinity of Hekla. The craters, through which it took place, are situated about four miles to the north-east of Hekla, in one of its outlying spurs. This eruption was preceded by severe earthquakes in the adjacent districts. These, however, caused very little damage.

Mr. Th. Thoroddsen has given the only account and full list we possess of volcanic eruptions and earthquakes in Iceland within historic times. A *résumé* of it is found in the *Geological Magazine*, 1880, pp. 458-467. A much fuller translation, with a bibliography on the subject, is given by Mr. George H. Boehmer in the Smithsonian Report for 1885, pp. 495-541 (Washington, 1886). It appears that no earthquakes in the history of the island were experienced over such an extensive area as the present ones.

The earliest recorded earthquake in Iceland took place in A.D. 1013. Of fifty-five recorded earthquakes, more than one half were not preceded, accompanied, or followed by eruptions. The earthquakes of 1789 were most severe. The section of land between the chasm of Almannagjà and that of Hrafnagjà settled 60 centimetres, and new hot springs were formed. But the area was restricted to the district of Árnessýsla, and no volcanic eruption took place from 1783 to 1821. Thus it is probable that, though the present earthquakes may not discontinue for some months yet, they will not be followed by an eruption. The largest number of eruptions—fourteen—have taken place in the eighteenth century, and it will be observed that both earthquakes and eruptions are, in each period, concentrated in certain districts of the country, and that, in succeeding each other in time, they rarely make large jumps. It is only the want of seismographic stations which prevents Iceland from being an object-lesson in seismology such as Japan. Iceland, however, cannot any longer with justice be counted among the unexplored regions of the earth. Mr. Thoroddsen has, during the last sixteen years, systematically explored a part of the island every year, and now that he has reached the end of his labours, it is to be hoped that the scientific world will not have to wait long for the publication of the results of his explorations. They promise to be of the highest interest, and will modify in many respects geological views regarding Iceland. The geological map of Iceland, published by Dr. Konrad Keilhack in 1886, is not to be depended upon, for its German authors have put down as actual facts many things which then were only assumed and surmised.

J. STEFANSSON.

THE GERMAN ASSOCIATION.

IN the presence of the Empress Frederick, and under the presidency of Geheimrath Prof. Dr. Hugo von Ziemssen, of Munich, the sixty-eighth meeting of the "deutscher Naturforscher und Aerzte," founded at Leipsic on September 18, 1822, was opened in the Saalbau, Frankfort-on-the-Main, on the morning of Monday the 21st ultimo. After the preliminary speeches by Prof. Moritz Schmidt and other citizens, the President briefly addressed the gathering; but the principal speakers were Prof. Hans Buchner, who devoted his address to "Biologie und Gesundheitslehre"; Dr. Neumayer, to Antarctic Exploration; and Prof. Lepsius, to "Cultur und Eiszeit." The gathering was then broken up into thirty sections, eleven of which were for the Naturalists, and nineteen for the various Medical and Surgical branches. The sectional meetings were held morning and afternoon (9 a.m. to 6 p.m.) till midday on Friday, and were well attended, there being, so far as could be estimated (the officials being unable to supply the precise figures), about 2500 gentlemen and 500 lady members. As there were some hundreds of papers under discussion during these days, and the titles of them alone would occupy several pages of NATURE, it will be sufficient here to mention only a few dealt with in some of the sections. Prof. Quincke opened the Physics Section with a paper "Ueber Rotationen im constanten elektrischen Felde," followed by Dr. Tuma, "Ersatz für den Ruhmkorff'schen Apparat." "Ueber Berührungselektricität," by Prof. Nernst; "Ueber den Vorgang bei langsamer Oxydation," by Prof. J. H. van 't Hoff; "Grundlagen seines neuen Systems der Elemente," by Dr. Traube; "Ueber die physikalische Isomerie," by Dr. Carl Schaum; "Demonstration einer Tafel des Systems der chemischen Elemente," by Dr. Wiechert; "Zur Elektrochemie des Kohlenstoffs," by Dr. Coehn; and "Ueber Kathodenstrahlen," by Prof. Lenard, were some of the communications discussed by the Physicists alone or with the Chemists. The Sections for Zoology, Pathology and Pathological Anatomy, and Physiology, joined in a discussion of the paper by Dr. Born, "Ueber künstlich hergestellte Doppelwesen bei Amphibien." The Section devoted to Ethnology, Anthropology, and Geography, had very little work to do, a day sufficing to get through it. Dr. Canheim had a paper on the Faroe Islands, and Dr. Rein on the North Coast of the Island of Hondo (Japan), and the Land and Sea Fauna of Kamaishi. With nineteen sections out of the thirty, the medical men were able to discuss a greater variety of topics than the physicists. Very interesting papers were read by Dr. Däubler on "Die Beri-Beri-krankheit," and by Dr. Glogner, of Batavia, on "Neure Untersuchungen über den klinischen Verlauf und die Aetiologie der Beri-Berikrankheit," and by Dr. Plehn, from the Cameroons, on "Erkrankungen der schwarzen Rasse in Kamerun vom October 1, 1894, bis April, 1896." But the doctors' field-day was Wednesday, when the Medical Sections, and a considerable number of members from the Physical Sections, assembled in the Saalbau, under the presidency of Prof. His, to discuss the latest discoveries in brain investigations. Prof. Flechsig's subject was "Die Localisation der geistigen Vorgänge"; Prof. Edinger's "Die Entwicklung der Gehirnbahnen in der Thierreihe"; and Prof. Ewald's "Ueber die Beziehungen zwischen der motorischen Hirnrinde und dem Ohrlabyrinth." The closing general meeting was held in the same room on Friday morning, when Dr. Max Verworn discoursed on "Erregung und Lähmung"; Dr. Ernst Below, on "Die praktischen Ziele der Tropenhygiene"; and Prof. Carl Weigert, on "Neue Fragestellungen in der pathologischen Anatomie."

Not the least important features of the Congress were the facilities afforded for inspecting the technical high schools, and the chemical and other establishments in the neighbourhood. Praise is due to the several local committees for the excellent manner in which they carried out their duties, the entertainments having been arranged on a most liberal scale, every night being devoted to recreation. At the close of the Sectional meetings on Friday, Profs. von Ziemssen, König, and the principal members of the Society proceeded to Friedrichshof, by command of the Empress Frederick, while the general body broke up into some half-dozen parties, who were conveyed to as many places in the country—to Darmstadt, to inspect the Technical Institute; to Hochst, to see the Serum establishment, &c. About 500 members accepted the invitation of the town of Homburg to proceed there on Saturday to breakfast, drive to the ruins of the Roman fortifications of Saalburg

to lunch, and to illuminations and fireworks in the Curhaus Gardens in the evening. A large party also went to Marburg on the same day. There was an abundance of literature specially prepared for visitors, and in addition to separate guides to Frankfort for the use of gentlemen and for ladies, Dr. Ziegler and Prof. König had published a large post quarto volume on "Das Klima von Frankfurt am Main" in which they discussed all available meteorological information, the letterpress occupying eighty-four pages, the tables fifty-one pages, and ten double-page diagrams. The records of ice on the river are complete from the year 1825, but prior to that date they are irregular, extending, however, as far back as January 1306.

Several rooms had been set apart for the exhibition of entomological collections; of Jenner relics (the centenary of inoculation for the small-pox); of Röntgen-ray photographs—of the manner in which the photographs are produced; and many other subjects of a scientific or medical character.

A large number of foreigners came to Frankfort to attend the meetings, those from England being Sir William MacCormac, Prof. Armstrong, Mr. Harries, and Drs. Semon and Thin.

NOTES.

THE Gatty Marine Laboratory, which is a continuation of the oldest Marine Laboratory in Britain, will be opened by Lord Reay on Friday, October 30. Invitations to the opening ceremony have just been sent out by the University of St. Andrews.

CABLEGRAMS from Australia report the death, at Melbourne, on October 9, at the age of seventy-one, of Baron Sir Ferdinand von Müller, the eminent botanist, who has added so much to our knowledge of the flora of our Australian Colonies. A German by birth, Baron von Müller had resided in Australia just half a century. He was a Fellow of the Royal Society, and Botanist to the Colonial Government.

THE death is announced of Dr. M. W. Drobisch, Professor of Philosophy in the University of Leipzig, and distinguished for his mathematical as well as his philosophical researches.

THERE seems to be no room for doubt that the company which has acquired the world-renowned Giant's Causeway, intends to prevent free access to it. The honorary secretary of the Ballymoney Sub-committee of the Defence Committee formed to assert public rights, having, in company with other members of the Sub-committee, visited the Causeway a few days ago, has received notice that a writ has been issued against him for trespassing upon the property of the syndicate.

PROF. MELDOLA, writing with reference to our note on wasps and flies (p. 549), says:—"I am glad you have again called attention to the useful part played by wasps in keeping flies in check. Many years ago, in an inn parlour on the Essex coast, I made a similar observation with Mr. W. Cole, who was with me at the time. We found hundreds of wings scattered about the window-ledge inside the room, and we were at first at a loss to explain the depredation. While watching, the mystery was solved. The upper part of the window had been left open a few inches, and a wasp came through, caught a fly on the glass pane, instantly clipped off its wings, and flew out of the open upper part of the window with the body. Other wasps followed and repeated the process. For about an hour we observed the continuous arrival of wasps, every one of which secured a fly before departing."

THE weather over the British Islands last week was unusually stormy; the reports issued by the Meteorological Office show that the atmospheric disturbances followed each other at short intervals, and were accompanied with heavy falls of rain in nearly all places. One of the most serious barometric depressions approached our islands from the south-westward on the 7th inst., and the disturbance moved during this and the following day along our extreme western coasts, causing heavy south-westerly gales and terrific seas in the west and north; over an inch of rain fell in twenty-four hours at several places, the amount measured at Holyhead, on the 8th, being 1·8 inches. During this severe gale the Daunt's Rock Lightship, near Cork, disappeared, with her crew of ten men. Notwithstanding the recent heavy rainfall, the reports show that there is still a deficiency of five inches from the average in the south-west of England since the beginning of the year, while the north of Scotland has had over six inches in excess of the normal amount.

LIVERPOOL lacks neither men nor societies devoted to the advancement of natural knowledge; what is apparently needed is the amalgamation of these societies for mutual assistance and support. Dr. H. O. Forbes, in an inaugural address delivered before the Biological Society of Liverpool on Friday last, urged the amalgamation of all Liverpudlian societies interested in biological science. He suggested that such a conjoint society, meeting in some central place and to be called, perhaps, the Biological Institute of Liverpool, or the Liverpool Institute of Natural Science, or if all the scientific societies could be induced to unite, the Royal Society of Liverpool, as was the suggestion, some ten years ago, of Prof. Herdman, might be instituted on the model of the New Zealand Institute. Such a combined society in Liverpool would command wider recognition, and contribute more to the advancement of science, than is at present possible with disjointed forces. Dr. Forbes also expressed the hope that two other scientific institutions of the highest educational value, urgently required in a city like Liverpool—a zoological garden and a resuscitated botanical garden under a trained botanist, both conducted in a thoroughly scientific manner—might be accomplished facts before the end of this century.

BLOWN-OUT shots are responsible for a large proportion of the explosions in coal mines. By a blown-out shot is meant a blast which has failed to effect a rupture of the coal owing to the hole for it having been drilled in a wrong position, or owing to the coal not having been properly prepared by holeing or under-cutting. The gaseous products produced by the combustion of the powder are driven violently into the roadways, mixed with the gas distilled from the coal; and this, with the clouds of dust raised at the same time, provides all the conditions for a disastrous explosion. The Commission appointed to inquire into the cause of the explosion at the Brunner Coal Mine, New Zealand, in March last, have, after full consideration of the evidence, concluded that the primary cause was a blown-out shot fired, contrary to the rules of the mine, in a part of the mine where no work should have been in progress. The coal-gas evolved from the surrounding coal is held to have been ignited as the result of the shot, and the flame then spread throughout the dry portions of the mine. The disaster was accentuated by the explosion of the coal dust raised by the concussion along the main road and working-places, which explosion appears, in some cases, to have been locally intensified by small quantities of fire-damp. No direct evidence was obtained by the Commissioners that the explosion was commenced by an accumulation of fire-damp, or that its extreme violence was due to the combustion of fire-damp mixed with coal-dust.

PROF. A. RÒITI (*Rend. Acc. Lincei*) continues his observations on the cryptochroism or phenomenon corresponding to colour in Röntgen rays. In one of his experiments it was

found that two plates of brass were equivalent in transparency to eight of aluminium, or sixteen sheets of tinfoil, but the same proportionality did not hold good in the case of certain other combinations of the three metals; thus proving that rays which have traversed a metal plate, differ from those directly emanating from the Crookes tube in their power of penetrating other plates of the same or different metal.

Whether high altitudes are productive of anæmia, or lead to an augmentation in the number of red blood-corpuscles, has long been a subject of controversy, the former view having been propounded by Jourdanet in 1863, and the latter by Viault in 1890. A series of observations bearing on this point are described by Dr. Kuthy in the *Atti dei Lincei*. Some of these observations were made on rabbits maintained in an artificially rarefied atmosphere, others on human subjects at high altitudes. In each case an apparent increase, both in the number of red corpuscles and in the percentage of hæmoglobin, was observed; but the author is inclined to regard this effect as due to a modification in the circulation of the blood, by which these constituents are brought to the surface of the body, rather than to a change in its actual constitution.

An American correspondent writes, under date October 2:—"The albatross flying machine of Mr. William Paul came to grief last Saturday. After waiting nearly a month for a favourable wind, a start was made from the chute after two hours of labour in placing the machine in position; but the first start did not get the machine off the ways. It was replaced a second time and started, but a sudden sideways gust of wind struck and tilted it, turning it about and back on its course. It dropped rapidly from a height of about sixty-five feet, striking a clump of trees, and thence falling to the ground. Mr. Paul was stunned, but not seriously injured. He will build a lighter machine of well-seasoned bamboo during the winter."

The most extensive and destructive West India cyclone on record swept across America on Tuesday and Wednesday, September 29 and 30, involving tremendous loss of life and property. The cyclone began on Sunday, south of Cuba. On Tuesday it struck the south-west coast of Florida, sweeping away almost the whole of the city of Cedar Keys, and passing through the State with great devastation. In the city of Jacksonville not a single building in the best residential quarter escaped serious injury. The storm inflicted great damage on the cities of Savannah and Brunswick on the coast of Georgia, with loss of life in both cities; and one hundred lives were lost on the sea islands along the same coast. Continuing northward, it spread a wide path of ruin through the country, including conspicuous destruction in Washington, and still more in Alexandria opposite to it, and in Baltimore, and through Eastern Pennsylvania. On Wednesday the storm raged in Michigan and extended to Milwaukee and Chicago, at which points great injury was done to shipping at wharves and outside, very many vessels having been sunk at the wharves in Chicago. The path of this storm was further west than that of the similar one in 1893, which devastated the sea islands and other localities, and the loss of life in this case was due more largely to the fall of débris than to the water.

The suggestion that the mineral composition of a sedimentary deposit may, if the source of its materials can be traced, afford evidence of the climate that existed during its formation, is not a new one. It has, for example, been put forward by Indian geologists in dealing with the Permo-Carboniferous glacial deposits in the southern hemisphere. It appears to have been independently arrived at by Mr. G. P. Merrill, as a result of his investigations on the decay of certain crystalline rocks. Using the term *degeneration* to cover *all* the processes by which a massive rock is brought to the state at which its materials are easily transported, he distinguishes the physical and mechanical processes as *disintegration* from the chemical one of *decomposition*. The former may be said generally to predominate in its results over the latter in cold and in dry climates; though many qualifying considerations must be taken into account. Apart from this generally interesting conclusion, the two papers by Mr. Merrill, on the granitic rocks of the district of Columbia, and on a diabase dyke at Medford, Massachusetts (*Bull. Geol. Soc. America*, vol. vi. p. 321; and vol. vii. p. 349), contain most detailed mechanical and chemical analyses of these rocks in various stages of degeneration, with full discussions on the evidence so obtained. It is to be hoped that many similar analyses may be made in other parts of the world, in cases where the conditions of occurrence are equally favourable.

In an elaborate communication by Prof. Bernhard Fischer, on the pollution of the water in the harbour of Kiel, some interesting determinations are incidentally given of the bacterial contents of several samples of sea-water made by Dr. Bassenge, on a voyage from Kiel to the Azores. Prof. Fischer himself made some time previously various examinations of sea-water selected from different places, and together the results furnish an interesting addition to our knowledge of marine-bacteriology. The average microbial contents of sea-water at some distance from land appear to be mostly under 250 per cubic centimetre, but in the English Channel, Skaggerack, Kattegat, and other more or less confined sea areas, the number reaches an average of 500 per c.c., and rarely rises above 1000 c.c. Near the coast and in sea harbours the number may be much higher; thus in Plymouth harbour as many as 13,320 per c.c. were found, although in the vicinity of Dartmouth only 800 bacteria per c.c. were obtained. Dr. Fischer attempts on these results to set up a numerical bacterial standard of purity for sea-water, and he has fixed upon a limit of 500 per c.c. as affording a safe index as to the unpolluted character of sea-water, whilst a higher figure should, he considers, be taken as a sure sign of contamination. With all due deference to Dr. Fischer's arbitrary standard, we think that there is too great a tendency at the present time to try and create bacterial numerical standards. Bacteriology does not admit of being dealt with on such a hard and fast basis, and whilst in some cases a large number of bacteria may mean nothing at all, and be without any further significance, on another occasion a far smaller number may be an index of danger. We have recently had an attempt to start a milk bacterial-standard; now we are to have a fixed sea-water microbial-measure, it only remains for our aërial surroundings to be bacterially standardised!

Another instance of the valuable work done at the Royal Gardens, Kew, in the organisation of botanical nomenclature, is afforded by the descriptive list of new garden plants of the year 1895, just issued as a *Bulletin of Miscellaneous Information*. To prepare and publish an annual list of the garden plants described in botanical and horticultural publications, both English and foreign, is no easy task; yet such a list, comprising all the new introductions recorded during last year, is now published. It hardly needs pointing out that lists of this character are indispensable to a correct nomenclature, especially in the smaller botanical establishments in correspondence with Kew. In addition to species and botanical varieties, all hybrids, whether introduced or of garden origin, with botanical names, and described for the first time in 1895, are included in the Kew list.

Under certain conditions, charcoal is liable to spontaneous combustion. The assertion has been made that charcoal used in building refrigerating chambers on shore and on board vessels has ignited spontaneously; but the evidence on this point

appears to be quite insufficient to support this serious charge. The results of an inquiry into the alleged liability of wood charcoal to spontaneous combustion, by Mr. W. D. A. Bost, have been published in a slender volume by Mr. Alexander Gardner. The fact of the matter seems to be that though freshly-made charcoal—that is, charcoal which has not absorbed its moisture—and oxygen is liable to so-called spontaneous combustion; it is never liable to re-ignite after having been exposed to the air for a few days. In any case, it seems that if after a few days no fire shows itself, the charcoal may be regarded as safe. The scare arising from the supposed danger from the ignition of charcoal used in insulating refrigerating chambers may, therefore, be regarded as groundless.

THERE appears to be no grounds for the statement made by Herr Schmeltz in the *Internationales Archiv für Ethnographie*, and referred to in NATURE, July 9, p. 237, that the Government of New Zealand had developed a sense of prudery in regard to the ithyphallic idols and figures in the Auckland Museum. Mr. T. F. Cheeseman, the Curator of the Museum, informs us that no idols whatever have been mutilated since the Museum has been under his charge, and the ethnographical collections have been almost wholly formed since his appointment. There are two or three large mutilated figures in the Museum, but that was done long before they came into the Museum, and probably dates from the period of missionary activity in New Zealand. Mr. Cheeseman very much doubts the accuracy of Herr Schmeltz's statement respecting the restriction of the importation of the phallic chalk figures from New Zealand. For many years such specimens have been on exhibition at the Auckland Museum, without objections being raised by the Government or any one else.

AT the last meeting of the American Institute of Mining Engineers, held at Denver in September, one of the most interesting papers read was on the "Micro-structure of Steel and the Current Theories of Hardening," by A. Sauveur. Mr. Sauveur recognises only four constituents of steel, viz. ferrite or pure iron; cementite or Fe_3C, isolated by Abel in 1855; pearlyte, an extremely intimate mixture of ferrite and cementite, arranged either in lamellæ or granules; and martensite, the composition of which cannot be determined by the microscope. Martensite exists only in hardened steel at ordinary temperatures, and is converted into pearlyte in the process of annealing. It appears to correspond with Arnold's hypothetical subcarbide, $Fe_{24}C$; but inasmuch as it is of variable composition, containing as little as 0·12 per cent. of carbon in very mild steel after quenching, and as much as 0·90 per cent. in hard steel, it follows that no single formula can express its composition. Mr. Sauveur is also dissatisfied with the allotropic theory of the hardening of steel, mainly on two grounds. First, he observes that the allotropists say that the iron passes from the hard β to the soft α state on cooling through the critical point Ar_2, and consequently iron quenched between Ar_2 and Ar_1 should be soft, while Mr. Howe has shown that it is hard. Secondly, according to the allotropic theory, slowly cooled non-magnetic manganese steel should be harder than quenched carbon steel; while, on the contrary, it is far less hard than steel containing much carbon. Mr. Sauveur suggests that the absorption or evolution of heat at the critical points is due to the structural changes which occur at these points. This seems to differ hardly at all from the views of the allotropists, for it is next to impossible to exclude structural changes, accompanied by thermal disturbances, from the list of allotropic changes. Lastly, Mr. Sauveur attributes the hardening of steel to the existence of a network of minute plates of Fe_3C disseminated through the mass; a view which will assuredly not put an end to the violent controversy which rages round this point, if indeed it meets with any support at all.

THE reference, in our last issue, to the first number of *Il Naturalista Siciliano* should have been to the first number of *a new series* of that periodical, which has been published continuously since 1882.

MANY naturalists may be glad to know that Mr. R. H. Porter, Cavendish Square, London, has just published a catalogue containing nearly four thousand titles of new and second-hand books on natural history offered for sale by him.

WE have received the *Proceedings* of the Natural History Society "Isis" of Dresden, for 1895, which is almost entirely occupied by a paper by the editor, Dr. O. Drude, on the distribution of eastern plants in the Flora of the Saxon Elbe-valley.

THE Division of Vegetable Physiology and Pathology of the U.S. Department of Agriculture has issued an important paper by Mr. W. T. Swingle (*Bulletin* No. 9), on the use of "Bordeaux mixture," a mixture of copper sulphate and lime, as a fungicide for vegetable crops.

MR. J. W. MARRIOTT has taken all the questions contained in the papers set by the Department of Science and Art in Practical, Plane, and Solid Geometry since 1884, and has arranged them on a graduated scheme, so that they can be used as exercises upon the various sections of the departmental syllabus. This graduated arrangement under different headings, and the lithographed diagrams accompanying the questions, should be of assistance to teachers of the subject. The questions are published in two sets—Elementary and Advanced—by Mr. E. Coward, Blackburn.

THE Meteorological Institute of Copenhagen has just distributed an important summary of the meteorological observations made in that city during the years 1751–1893. This period embraces no less than 143 years; but from various causes, the results of several of the intermediate years are missing, and the observations have naturally been taken at various hours and localities. Since 1874 they have been made under the immediate superintendence of the Institute, and consequently these possess a much higher value than the earlier series. The annual temperature varied between 49·3° and 41·2°. The mean annual rainfall was 22·1 inches. The summer is the wettest season; the winter and spring being much dryer than the other seasons. The author (Mr. V. Willaume) discusses the data from various points of view, *e.g.* their possible connection with sun-spots, and the moon's influence.

THE *Proceedings* of the Rochester (New York) Academy of Science, Brochure i. of vol. iii. of which has lately come to hand, is a pleasing production, and is a proof that no pains or expense are spared to make it thoroughly attractive in appearance. The section before us is occupied by a paper by Florence Beckwith and Mary E. Macauley, assisted by Joseph B. Fuller, on "Plants of Munroe County, New York, and adjacent territory." The list aims at the inclusion of the names of plants growing without cultivation in Munroe and adjoining counties, and care has been exercised in the determination of specimens, the authors having excluded all those concerning which there have been reasonable doubts. A general comparison is given of the Munroe flora, with lists of plants covering territory east and west of the area under discussion, *i.e.* the territory of Buffalo and the area of Cayuga, and the result as given by them is as follows: The total number of species enumerated in the Buffalo list is 1289, that in the Cayuga flora is 1278, and that in the Munroe list is 1309. The paper is illustrated by a map of the region discussed, and by a diagram showing the stratigraphy of the same.

The additions to the Zoological Society's Gardens during the past week include two Lions (*Felis leo*, ♂ ♀) from North-east Africa, presented by Mr. C. A. Osborne; two Globose Curassows (*Crax globicera*, ♂ ♀) from Central America, presented by Mrs. Sedgwick; a Whinchat (*Pratincola rubetra*), a Redstart (*Ruticilla phœnicurus*), a Blackcap (*Sylvia atricapilla*), a Swallow (*Hirundo rustica*), British, presented by Mr. John Young; a Cape Viper (*Causus rhombeatus*) from South Africa, a Rufescent Snake (*Leptodira rufescens*) from East Central Africa, presented by Mr. F. V. Kirby; a Smooth Snake (*Coronella lævis*), European, presented by Mr. A. E. T. Jourdain; two Hairy Armadillos (*Dasypus villosus*) from La Plata, a Peba Armadillo (*Tatusia peba*) from South America, deposited; two Maguari Storks (*Dissura maguari*) from Chili, three Laughing Gulls (*Larus atricella*) from North America, purchased; two Collared Fruit Bats (*Cynonycteris collaris*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

Astronomical Society of Wales.—We have received the *Journal* of this Society for September, and find it contains some useful information for amateurs. Besides current notes and some short contributions from various members, a brief description is given of the conditions under which Mars is now visible. This is accompanied by some illustrations, among which is an excellent map of Mars, by Schiaparelli. We notice in the table given at the end, describing "The Heavens" for October, that the period of the variable star η Aquila is given as two days nine hours; this is evidently incorrect, being the time from a minimum to a maximum. A variable star period is generally reckoned either from minimum to minimum, or from maximum to maximum, and its length in the case of this star is, roughly, seven days four hours.

The Elements of Comet 1885 III.—Both Messrs. W. W. Campbell and Gallen Müller have calculated the elements of the orbit of this comet, discovered by Mr. W. R. Brooks at Phelps, New York, on August 31, 1885. These computations were made independently of one another. Mr. Campbell's work led us to believe the orbit of this comet to be an ellipse, with a period of revolution of 495·7 years; while Mr. Müller gave us two orbits, one elliptical with a period of 403·2 years, the other a parabolic orbit. It seems that the observations used as a basis for the calculation, both include one made at Dun Echt by Dr. Copeland on October 5. This observation forms the last placed position in both calculations. On this the value of the eccentricity obtained entirely depends. Owing to this uncertainty, the observation has been replaced by three observations by M. Bigourdan, which had not been published when the calculations were commenced. These latter observations get rid of this difficulty, and give us the means of ascertaining whether the eccentricity is real or not. The computation has been undertaken by Mademoiselle Klumpke, at the request of Prof. Schulhof, and is published in the *Bulletin Astronomique* for September. The investigation shows that the new elements deduced give a period of revolution of 247·5 years. This period is, as Mademoiselle Klumpke says, with certainty relatively short. It takes a fifth place among those comets, the time of revolution of which is greater than a hundred years. Mademoiselle Klumpke further suggests that the theory of the capture of comets would attribute the elliptical character of this orbit to the action of Jupiter, the minimum distance between the two orbits being 0·22. The following are the elements finally deduced:—

Final Elements.

$$\begin{aligned} T &= 247^\circ\ 36'\ 57''{\cdot}65 \\ \Omega &= 204\ 45\ 24{\cdot}52 \\ i &= 59\ 6\ 35{\cdot}43 \\ \log q &= 9{\cdot}8745682 \\ e &= 0{\cdot}9822627. \end{aligned}$$

The Leander McCormick Observatory.—The *Alumni Bulletin* of the University of Virginia contains an account of the principal work in hand at the Leander McCormick Observatory. At present the chief work is the observation of the relative positions of the satellites of Saturn, and the discussion of the measures for the purpose of improving our knowledge of their motions.

The orbits of Titan and Japetus are fairly well known, so special attention is given to the remaining satellites. All of these are faint, and a powerful telescope is needed to observe them accurately. The most easily observed are Rhea, Dione, and Tethys, and a fine series of relative positions of these has already been secured, from which it is hoped to obtain greatly improved orbits of those bodies. Mimas, the satellite nearest to the ring, is very faint, so that it can be observed only under favourable atmospheric conditions, and only when near the points in its orbit where its apparent distance from Saturn is greatest. As a result the inequalities in its motion are not at all well known, and further observation is desirable. The same is true to a less extent of Enceladus, the next satellite beyond Mimas. The orbits of both these satellites are useful in determining the mass of Saturn's ring. Hyperion is also extremely faint. The motion of this satellite is greatly affected by the attraction of Titan, and the determination of its orbit involves difficulties that render it one of the most interesting problems of the solar system.

The observations of these satellites are being published from time to time in the *Astronomical Journal*. Their discussion has occupied the attention of the Director during a large portion of the past year. The investigation is of great importance, and the results obtained will lead to the gradual solution of the mechanical problems involved in the motions of the Saturnian system.

The Solar Rotation.—The great amount of material that we now possess with regard to solar phenomena has led many to form theories of the rotation of the sun, which differ among themselves both in the method of treatment employed and in their value. Of those more recent, that which we owe to E. J. Welczynski, is published in the current number of the *Astrophysical Journal* (August 1896). The author commences by forming the hydrodynamic equations of Lagrange, by assuming the coordinates of any point of a fluid, and the position of this point at a certain time ($t = 0$). A fourth equation is obtained further by differentiating with regard to the time, the product of the density of the fluid at the initial position, and a determinant containing (in rows) the differential of the coordinates of the first point to those of the second. He then proceeds to rotate the whole mass round the axis of z, where ω is the angular velocity of rotation depending on the coordinates of the point $t = 0$. The equations then become simplified, and it is found that the square of the angular velocity is a function of the distance of the moving point from the axis of rotation, or, in other words, ω depends only on the value of r. The equations of Lagrange thus become further simplified, and conditions are inserted for the case in which the fluid is a gas, and the absolute temperature not constant throughout. The equation arrived at finally is

$$4\pi\rho + c\Delta T + c\Delta \log \rho = 2\omega^2 + r\frac{d\omega^2}{dr}.$$

Welczynski then identifies this rotating mass with the sun, which he assumes spherical. Since ω depends on r, he imagines the sun's axis the common axis of a series of cylinders, so that the velocities of points on the surfaces of each of these would be constant for each cylinder, the surfaces rotating as if they were solid. "But from one cylinder to another ω changes according to a certain law, $\omega = f(r)$, which, according to (10) [equation given above] depends upon the distribution of temperature and pressure in the sun's interior. Since we know nothing of these qualities it is impossible to deduce theoretically a formula for the solar rotation." He remarks further that it is important to note that "if $\omega = f(r)$ is known from observation, equation (10) gives a condition which the temperature and density of the solar interior must satisfy. If it were possible to find a second condition of this kind, it would be possible to find the laws according to which these quantities vary from point to point." He suggests that such an equation would follow if the periodicity of the sun-spots be a hydrodynamic phenomenon. The paper concludes with a reference to the position of the faculæ with reference to these spots. The faculæ being further from the centre of the sun than the spots, the former, even on the same heliographic latitude, would move faster, as the velocity of rotation increases the greater the distance from the sun. In fact a means is afforded here of determining the difference in the altitude of spots and faculæ, this difference being stated to be "considerable, almost 1/60 of the solar radius."

THE HUXLEY LECTURE.—RECENT ADVANCES IN SCIENCE AND THEIR BEARING ON MEDICINE AND SURGERY.[1]

I.

When fifty-four years ago the school of Charing Cross Hospital gathered itself together for its winter work, among the new comers was a pale-faced, dark-haired, bright-eyed lad, whose ways and works soon told his fellows that he was of no common mould. To-day I am about to attempt the fulfilment of the duty, which the authorities of the school have done me the honour to lay upon me, of delivering the first of the series of lectures which the school has wisely instituted to keep alive, in the minds of those to come, the great services which that lad's strenuous and brilliant life rendered to the healing art. The trust of the Huxley Lectureship provides that the lecturer shall dwell on recent advances in science, and their bearings on medicine and surgery. I venture to hope that I shall be considered as not really departing from the purpose of the trust, if I attempt to make this first lecture a sort of preface to the volume, or rather the volumes of lectures to come. And since a preface bears a different paging, and is written in a different fashion from that which it prefaces, I shall be so bold as, with your permission, to make the character of my lecture to-day different from what I suppose will be that of the lectures of my successors. It will, I imagine, be their duty to single out on each occasion some new important advance in science, and show in detail its bearings on the art of medicine. Each succeeding lecturer will, in turn, be limited in the choice of his subject, and so assisted in his task by the choice of his predecessors. I to-day have no such aid. It seems fitting that, for the purposes of this initial lecture, the word "recent" should be so used as to go back as far as the days of Huxley's studentship. If it be so used, I am brought to face advances in science affecting medicine and surgery, so numerous and so momentous that any adequate treatment of them as a whole would far exceed not only the time at my disposal, but also, what is more, my powers to treat and your patience to hear. I will not dare so hopeless a task. Nor will I attempt to select what may be deemed, or what may appear to me, the most important of these advances, and expound the bearings on medicine of these alone. I venture to hope I shall best fulfil the duty laid upon me, and meet with your approval, if I single out and dwell on one or two general themes suggested by the history of science during those fifty odd years.

The first theme is one suggested by a survey of the studies which engaged young Huxley in the school here in 1842. This will bring before us a special bearing, on our profession, of the advance of science, which, though it may not be evident at first sight to every one, is nevertheless real and important.

Each case of illness is to the doctor in charge a scientific problem to be solved by scientific methods; this is seen more and more clearly, and acknowledged more and more distinctly year by year. Now it is true that each science has to a certain extent its own methods, to be learnt only in that science itself; and from time to time we may see how a man eminent in one branch of science goes astray when he puts forward solutions of problems in another branch, to the special methods of which he is a stranger. In nothing is this more true than in an applied science like that of medicine. At the bedside only can the methods of clinical inquiry be really learnt; it is only here that a student can gain that kind of mind which leads him straight to the heart of disease, that *genius artis*, without which scientific knowledge, however varied, however accurate, becomes nothing more than a useless burden or a dangerous snare. Yet it is no less true that the mind which has been already sharpened by the methods of one science takes a keener edge, and that more quickly, when it is put on the whetstone of another science, than does a mind which knows nothing of no science. And more than once inquiry in one science has been quickened by the inroad of a mind coming fresh from the methods of a quite different science. For all sciences are cognate, their methods though different are allied, and certain attitudes of the mind are common to them all. In respect to nothing is this more true than in respect to the methods of medicine. Our profession has been the mother of most of the sciences, and her children are ever coming back to help her. In our art all the sciences seem to converge—physical, chemical, biological methods join hands to form the complete clinical method. This is the real justification for that period of preparatory scientific study, which each enactment of the authorities makes longer and harder for the student of medicine. It is this, and not the mere acquirement of facts. The facts, it is true, are needed; every day the doctor has to lay hold, for professional use, of mechanical, physical, chemical, biological facts. But facts are things which the well-trained mind can pick up and make use of as it goes along at any time and in any place. Whereas the mind which is not well-trained will miss the facts or pick up the wrong ones, or put to a wrong use even the right ones which it has in hand.

Now the ideal training to be got from any science is that of pursuing inquiry within the range of the science, according to the methods of the science; in that way only does the spirit of the science fully enter into the man. But such an ideal education is impossible. We are fain to be content in merely making the student know what truths in each science have been gained and how they have been gathered in, such a teaching becoming more and more effective as a training, the more fully the student is made to tread in the very steps, and thus to practise the methods of those who gained the truths.

The more complete the body of any one science the more useful does that science become as a means of training, and hence it is that advance of science has a double bearing on the medical profession. As each science grows, not only does its new knowledge bring to the doctor new facts and new ideas, new keys to open locked problems, and new tools to use day by day, but the incorporated knowledge gains greater and greater power as an instrument to train his mind rightly to use all the facts which come before him.

Let me, in the light of this view, call your attention for a moment to the yoke of compulsory studies under which the young Huxley had to bend his somewhat unruly neck, and compare it with the like yoke which presses, heavily it seems to some, on the neck of the young student of to-day.

I have not been able to find an exact record of the course of studies pursued by Huxley himself at Charing Cross in the years 1842–5, but I have been privileged to examine the stained and tattered schedule of the College of Surgeons, duly "signed up," for the years 1844–7, belonging to one who, during some of those years, sat by Huxley's side, who was then, and afterwards, his friend, and who has won honour for himself and for your school, under the name of Joseph Fayrer.

I find that young Fayrer attended during his first year a course of at least 140 lectures with 100 demonstrations on Anatomy and Physiology, a course of not less than 70 lectures on Materia Medica, a course of lectures on the Practice of Surgery, and a course of "The Practice of Physics," each of not less than 70 lectures, and a course of Hospital Practice in Surgery of not less than nine months. In his second year he again attended the 140-lecture course on Anatomy and Physiology, and the 70-lecture course on the Practice of Surgery, and again Hospital Practice in Surgery, taking as well a 70-lecture course in Chemistry, a like course in Midwifery and Hospital Practice in Medicine. In his third year he once more attended the 140-lecture course in Anatomy and Physiology, but no other systematic lectures; the rest of his time was devoted to Hospital Practice. To these demands of the College of Surgeons we ought to add, in the case of the ordinary student, the demands of the Company of Apothecaries; but the main addition thus caused would be a course of Botany.

Such a curriculum differs widely both in nature, extent, and order from that in force at the present day. But I venture to think that if we examine the conditions of the time, we shall find that the authorities of that day were as wise as, possibly wiser than, we of to-day. In judging such matters as these, we and, perhaps, especially they who would drive the student on into learning by the goad of compulsion, must bear in mind that legislative enactments, such as those prescribing a curriculum of study, always exhibit a long latent period; they come into visible existence long after the stimulus which begat them has been applied, long after the need of those things being done which the enactments strive to do has been felt. So long, indeed, is the latent period, that often new needs have arisen calling for yet other regulations before the old ones appointed to meet the old needs have got into working order. Bearing this in mind, we shall find that the course of study prescribed in Huxley's time was wisely chosen to meet the needs of, at least, the time immediately preceding that, if not, indeed, the time itself.

It will be observed that the study of physics, or as it was then more commonly called natural philosophy, finds no place what-

[1] Delivered at Charing Cross Medical School, on October 5, by Prof. Michael Foster, Sec.R.S.

ever in young Fayrer's schedule, and that the one short course of chemistry, without any practical instruction, which he attended was taken in his second year—in the middle, as it were, of his curriculum, when he was already advanced in his clinical studies.

At the present time the sciences of physics and chemistry have each of them developed into a body of logically coordinate truths, furnishing an instrument of peculiar value for the training of the scientific mind. Moreover the methods of teaching have developed in no less a degree, so that in the laboratory the student follows, at a long distance, it is true, but still follows the steps of those who have made the science, and has at least the opportunity of catching something of the spirit of scientific inquiry. In this educational value of these sciences, even more than in the practical utility of a knowledge of the mere facts of the sciences, great as that may be, lies the justification of the authorities when these, desiring to improve the profession by introducing artificial selection into the struggle for existence, insist that all to whom the lives and health of their fellow men are to be entrusted, should have learnt at least something of the sciences in question.

In the time of Huxley's studentship both these sciences were in a very different condition. The time, it is true, was one of great awakening. In physics men's minds were busy opening up the hidden powers of electricity: some ten years before Faraday had made an epoch by discovering induced currents; he and others were still rapidly extending our knowledge, one practical outcome of which was the introduction of the telegraph in 1837. But how great has been the onward sweep in electric science since then; how great the advance in all branches of physics! To realise the great gap which separates the physics of to-day from the physics of then, one has only to call to mind that the world had yet to wait some years before Mayer, and Joule, and Helmholtz, and Grove had said their say; in the books which taught young Huxley the laws of physics he found not a word of that great law of the conservation of energy, which like a lamp now guides the feet of every physical inquirer, whatever be the special path along which he treads.

In chemistry much, too, was being done. That science was in the first flush of success in its attack on the mysteries of organic compounds. Liebig, Dumas, and others were rapidly making discoveries of new organic bodies, and dealing with types and substitution, were beginning to make their way into the secrets of chemical constitution; but then, as indeed for a long time afterwards, progress was taking the form of the accumulation of new facts interesting and eminently useful, but still mere facts, rather than of the gaining of insight into those laws of chemical change of which the facts are but the expression. And the brilliant success of purely organic chemistry was somewhat prejudicing those inquiries in regions where physics and chemistry touch hands, which in these latter days are producing such striking results.

In the days of Huxley's studentship neither of these sciences presented such a body of truths as could be readily used as an engine of mental training, nor had the educational mechanism for thus employing them been developed; a chemical laboratory for the student was as yet hardly known, a physical one wholly unknown. The profession turned to these sciences chiefly for the utility of the facts contained in them. The facts of physics, with the exception of those of mechanism, were but rarely appealed to, and if those of chemistry were in more common use, it was because they threw light on the mysteries of the Pharmacopœia, rather than because they helped to solve the problems of the living body. Hence the authority, not without cause, demanded of the student no physics at all, and asked for chemistry only in the midst of his course, when its facts might help him to understand the nature of the drugs which his clinical studies were already bidding him use.

As regards the biological sciences, the time was also one of change, or rather of impending change; the causes of the change were at work, but for the most part were at work below the surface; their effects had not yet become obvious.

In natural history, in what we sometimes now call biology, in botany, zoology, and comparative anatomy, the activity in systematic and descriptive work was great. The sun of the great Cuvier was setting, but that of our own Richard Owen was at its zenith; new animal forms, recent and extinct, were daily being described, the deep was giving up its treasures, new plants and new beasts, brought home by energetic travellers, were being duly investigated. But this was only a continuation of what had been going on long before.

Of the great biologic revolution which was about to come, there was not so much as even a sign in the skies when Huxley took his seat on the Charing Cross benches, though Charles Darwin was already brooding over the ideas which had come to him in his long voyage.

Two great changes, however, were already beginning—one due to new ideas, the other to improved methods.

The morphological conceptions, of which von Baer, in his "History of Development," had laid the foundations, destined to make a new science of animal forms, were being carried forward by Johannes Müller in Germany, though, save for the expositions of Carpenter, they had made but little way in this country. Nowhere, indeed, had they progressed far. The man who, perhaps to Huxley himself, was to advance them most, Gegenbaur, was as yet a mere student. Nor in spite of the beginning made by von Baer himself, by Allen Thomson, and by Rathke, had embryology made much progress. Kölliker, to whom the science owes so much, had as yet written no line. Still the new ideas were beginning to push.

Of no less importance was the impulse given by the improvements in the microscope. Only ten years before Sharpey, discovering that eminently microscopic mechanism ciliary action, found that a simple lens was a much more trustworthy tool than the then compound microscope. But in the ten years a great change had taken place, and during the latter part, especially, of the decennium, improved instruments yielded a rich harvest of discovery in animal and vegetable life. Prominent among the new additions to truth was increased knowledge of the mammalian ovum, in acquiring which Wharton Jones, Huxley's teacher at Charing Cross, did much. But the most momentous and epoch-making step was the promulgation of the cell-theory by Schwann and Schleiden as the decennium drew to its close, and more or less connected with that step was the accurate description by von Mohl of the structure of the vegetable cell, and his introduction of the word, which, next to the word cell, has perhaps had the most profound influence on the progress of biologic science—I mean the word protoplasm.

Of this wide field of general biologic knowledge the College of Surgeons at that time took no heed, or at least made no formal demand. It is true that part of it found its place in the lectures on Anatomy and Physiology, and in the consequent examinations, but only a small part. It is also true that the lecturer on Materia Medica had by custom license to roam over almost the whole of nature, and the student in learning the nature and use of drugs took doses of heterogeneous natural history; the mention, for instance, in the Pharmacopœia of Castoreum being made the occasion of a long disquisition on the biology of the beaver.

But in this the end in view was the acquisition of facts, not training in scientific conceptions and ways of thought.

The botany, it is true, which unasked for by the College of Surgeons, was insisted upon by the Company of Apothecaries, though made compulsory on utilitarian grounds, as an appendage to and introduction to the Pharmacopœia, did serve the student in an educational way, teaching him how to appreciate likenesses and differences, even small ones, and how to distinguish between real and superficial resemblances. But the time he spent on this was too brief to make it—save in cases where a special enthusiasm stepped in—of any notable effect.

Of the then conditions of that biologic science which comes closest to the profession of physiology, I will venture to say a few words, though I will strive to curb my natural tendency to dwell on it at too great a length.

A great master—Johannes Müller—had a few years before written a great work, "The Outlines of Physiology," a work which the wise physiologist consults with profit even to-day, noting with admiration how a clear strong judgment may steer its way through the dangers of the unknown, and the still worse perils of the half-known. A study of that work teaches us the nature and extent of the advanced physiology, which at that day an accomplished teacher like Wharton Jones might put before an eager student like Huxley, and we may infer what the ordinary teacher put before the ordinary student, each perhaps then, as since, eager neither to give nor to take more than the statutory minimum.

When we look into the past of science, and trace out the first buddings of what afterwards grow to be umbrageous branches, it sometimes seems as if every time, and almost every year, marked an epoch; it seems as if always some one was finding out something which gathered into greatness as the following years rolled on. But even bearing this caution in mind, the end of the thirties and the beginning of the forties of the present

century do seem to mark a real epoch in physiology. All along the line, accurate careful observation, quickened by the rapid growth of the cognate sciences, was taking the first steps to replace by sound views the sterile discussions and scholastic disquisitions which had hitherto formed too large a part of physiological teaching. The first steps had been taken, but the most marked advance was yet to come.

Though the observations of Beaumont had a few years before, by proving that gastric juice was a real thing, and demonstrating its properties, shown the nature of digestion in its true light, the older fermentative and other theories were not yet abandoned by all. Though the conversion of starch into sugar had been recognised, and pepsin had been discovered, the exact action of the digestive juices had yet to be learnt; that of pancreatic juice was almost unknown, and bile still reigned as the king of enteric secretions.

In the physiology of respiration the view that the carbonic acid of expired air was formed in the lungs by the oxidation of the carbon of the blood, still found strenuous support; for Johannes Müller found it necessary to argue at great length that the researches of Magnus on the gases of the blood had placed the matter in its true light. It had been suggested that the red corpuscles were in some way also special carriers of oxygen from the lungs to the tissues, but Müller could not regard this as anything more than a mere supposition.

When it is borne in mind that injection with mercury was the one method employed for tracing out the course of the lymphatics, it will be readily understood how imperfect was the then knowledge of the lymphatic system. And when it is also remembered that though Dutrochet had long before used osmosis to help in the interpretation of the movements of liquids in living tissues, the exact researches of Graham had yet to come, it will also be understood why, when questions of absorption and cognate questions of secretion came under consideration, they were dealt with as questions in such a condition are dealt even nowadays; much was said about them because little was known.

Though Poisseuille, taking up the matter where it had been left by Stephen Hales in the foregoing century, had begun, and the brothers Weber were just continuing, the work of placing our knowledge of the mechanics of the circulation on a sound and exact basis, and though the then teaching of the mechanical working of the heart did not differ widely from that of to-day, the gap which separates the then knowledge of the circulation, even in its mechanical aspects, from that which we possess to-day, is seen in all its width when I remind you that Carl Ludwig's first paper was not published until Huxley had ceased to be a student—until the year 1845. As to all that great part of the physiology of the vascular system which concerns its government by the nervous system, I will only say that in Müller's great work may be read the pages in which he deals with the conflicting opinions and indecisive observations as to whether the brain and spinal cord have any influence over the heart-beat, and in which, marshalling with logical force the arguments for and against the opinion that the blood-vessels have muscular fibres in their walls, finally decides that they have not.

In the physiology of the nervous system a momentous advance had been made some few years before, in the early thirties, by the introduction, through Marshall Hall, of the idea of reflex action. This was rapidly supplying the key to many hitherto unsolved physiological and clinical problems. The special functions of the several cranial nerves were being worked out by Majendie, Reid, and others. The former (with Flourens) was also making many experimental researches on cerebral lesions; and, in another line of inquiry, Bidder and Volkmann were preparing the way for discoveries to come by their important studies on the sympathetic system. The physiology of the senses was being vigorously pushed forward by Johannes Müller; but the reader to-day of Müller's volumes cannot but be struck with the smallness of the space (if we omit all that deals with the senses) which he allots to the nervous system, when we compare it with what is demanded in the present day. And no little part of even that limited space is taken up with a consideration of the laws of those "sympathies" which gave to the sympathetic nerves their name, but which have long since dropped out of sight.

Lastly, it must be remembered that many of the speculations of the preceding part of the century had remained barren, and many investigations had gone astray through lack of knowledge of the minuter changes which lie at the bottom of physiological events. Those minuter changes could not but lay hidden, so long as there was no adequate knowledge of minute structure. I have already referred to the improvements of the microscope taking place in the thirties, and this soon bore fruit in the rapid growth of that branch of biologic science once called general anatomy, later on microscopic anatomy, and now best known by the name of histology. It is well-nigh impossible to exaggerate the importance of a histological basis for physiological deductions; it is one of the chief means through which progress has been made, and must continue to be made. In the earlier days of physiology, the grosser features of structure forming the subject-matter of ordinary anatomy guided the observer to the solution of problems about functions; but after a while these became exhausted, having yielded up all they had to yield, and in due time their place was taken by the finer features disclosed by the microscope. These show as yet no signs of exhaustion, and we may look forward in confidence to their standing us in good stead for years to come. We may expect them to last until we pass, insensibly, from that molecular structure which makes itself known by optical changes, to that finer molecular structure which is only revealed by, and inferred from its effects, which is an outcome of the ultimate properties of matter, and which is the condition, and so the cause, of all the phenomena of life.

The early forties of the present century may be taken as marking the rapid rise of histological inquiry. It is true that, even before this, the labours of Henle had gone far; that in this country the brilliant Bowman had already (in 1840) given to the world his classic work on the structure of striated muscle, and a little later (1842) his hardly less important work on the structure of the kidney; that the sagacious Sharpey had embodied, in "Quain's Anatomy," a whole host of important histological observations; and that many others were at work. Nevertheless, one has only to remember how closely the progress of histology is bound up with the name of Kölliker, and to call to mind that Kölliker's first paper was not published until 1841, to see clearly how much of our present knowledge of histology, and all that that brings with it, has been gathered in since Wharton Jones taught it to the young Huxley.

If the gap which parts the physiological learning of that time from the learning of to-day is great, still greater is the gap in the teaching. Though at Charing Cross and in some other schools a course of physiology was given, apart from that of anatomy, this was not separately recognised by the College of Surgeons; it demanded simply a course of anatomy and physiology, of which the lion's share fell undoubtedly to anatomy.

In accordance with this, in most schools, at all events the greater part, and perhaps the sounder part of the physiology taught, was that which may be deduced from anatomical premises. Where the teacher went beyond this, he in most instances at least wandered into academical disquisitions and sterile discussions. Only in rare hands, such as those of Wharton Jones and William Sharpey, was the subject so treated as to be of any real use as a mental training for the medical student preparing his mind to view rightly biological problems. The science was not as yet sufficiently advanced to be an educational engine which could be safely entrusted to the ordinary teacher's use. And the method of teaching it, happily recognised now, which alone ensures the salutary influences of the knowledge acquired, that of following out in the laboratory the very steps along which the science has trod, was then wholly unknown. It was as a brilliant favourite pupil that young Huxley was encouraged by Wharton Jones to use the microscope himself, and study among other things the structures of hairs; he was not led to it, as one of a flock, in a practical course.

Indeed one kind of knowledge only was at that time demanded of the medical student, in such quantity and in such a way as to render the study of it a real mental training. Not in one year only of his course, but in each year—in his first, his second, and his third year—was the student, who hoped to obtain the diploma of the College, compelled to attend lectures, each course consisting not as in other subjects of seventy, but of double that number of lectures, on what was styled anatomy and physiology, but was in the main what we now call anatomy. Moreover, the student learnt even then his anatomy in the same way that he is bid to learn all other subjects now, not merely by listening to lectures, or even by witnessing formal demonstrations, but by individual labour in the laboratory, in that laboratory which we call a dissecting-room. Nowadays it may seem strange to insist

that the student should be studying anatomy during all the three years of his curriculum, down to the very end of his studentship But we must admit the wisdom of it then. At that time human anatomy was the one branch of knowledge which had achieved anything like complete development, and which successive generations of able teachers had shaped into an engine of mental training of the highest value. It was then the mainstay of medical scientific teaching. It was in the dissecting-room that the student, of the time of which we are speaking, acquired the mental attitude which prepared him for the bedside. He there learnt to observe, to describe, to be accurate and exact, and the time spent there was wisely judged to be the most precious of his apprenticeship; the shaping of his mind by help of orderly arranged facts was perhaps even of greater value than the mere acquisition of the facts, important as this might be.

The authorities of the time were, I venture to repeat, in my opinion wiser in their generation in making this well-developed, adequately taught science of anatomy the backbone of the medical student's education; they were wise in making relatively little demand on the student in respect to the other sciences cognate and preparatory to medicine, the value to him of which consisted then chiefly in the facts which they embodied; they were also wise in giving him leave to defer his study of them until his knowledge of something of the needs of his future profession should have opened his eyes to the value of those sciences as mere records of facts.

I also, however, venture to think that the advance of these sciences since then has greatly changed their bearing towards the medical student, no less than towards medicine. What was wisdom in the forefathers is not necessarily wisdom in us the children. I have no wish to take advantage of the occasion of this lecture to make an excursion into the troubled land of medical education. But I feel sure—indeed I know—that I am only saying what the man whose name these lectures bear always felt, and indeed often said, when I suggest for consideration the thought that while some choice out of that advancing flood of science which is surging up around us, and all of which has some bearing on the medical profession, some choice as to what must be known by him who aspires to be the instrument of the cure and prevention of disease is rendered necessary by the struggle for existence—a decided and even narrow choice, lest the ordinary mind be drowned in the waters which it is bid to drink. In making that choice, we should remember that an attitude of mind once gained is a possession for ever, far more precious than the facts which are gathered in with toil, and flee away with ease. This should be our guiding principle in demanding of the medical student knowledge other than that of disease itself.

The usefulness, and so the success, of a doctor is largely dependent on many things which belong to the profession viewed as an art, on quickness of insight, promptness of decision, sleight of hand, charm of manner, and the like—things which cannot be taught in any school. But these are in vain unless they rest on a sound and wide knowledge of the nature of disease, on a sound and wide grasp of the science of pathology; and this can be taught. By a sound and wide grasp, I mean such a one as will enable him who has it to distinguish, as it were by insight, among the new things which almost every day brings to him that which is a solid gain, from that which is a specious fallacy. Such a grasp is only got by such a study as leads the mind beyond the facts into the very spirit of the science.

But what we call pathology is a branch—a wide and recondite branch, but still a branch of that larger science which we call physiology; it employs the same methods, but applies them to special problems. So much are the two one that it would doubtless be possible to teach pathology to one who knew no physiology; such a one would learn physiology unawares. But at a great waste of time. For physiology, in its narrower sense, being older, has become organised into an engine which can be used for leading the mind quickly and easily into the spirit and methods of true pathological inquiry. The teaching of it as an introduction to pathology is an economy of time. That, I take it, if compulsion be justifiable at all, is the justification of its being a compulsory study.

Further, the methods of physiology, in turn, are the methods of physics and of chemistry, used hand in hand with other methods special to the study of living beings, the general methods of biology. And here again it is an economy of time that the student should learn these methods each in its own science, and this is the justification for making these sciences also compulsory. But in all the regulations which are issued concerning these several ancillary sciences, this surely should be kept in view, that each science should be taught not as a scientific accomplishment of value in itself, but as a stepping-stone to professional knowledge, of value because it is the best means of bringing the student on his way to that.

(*To be continued.*)

CHEMISTRY AT THE BRITISH ASSOCIATION.

THE meeting of the Chemical Section of the British Association at Liverpool was not signalised by the announcement of any sensational discovery. Papers were, however, read on a number of the subjects which are at present occupying the attention of our foremost chemists, and it is to be hoped that the discussion on chemical education may help in attracting the attention of the public to that most important subject.

After the President's very interesting address, which, as was pointed out by Sir F. Abel, dealt with an industry of which the development had been mainly due to the labours of English chemists, many of whom worked in the immediate neighbourhood of Liverpool, the ordinary business of the Section was commenced with a paper on "Reflected Waves in the Explosion of Gases," by Prof. H. B. Dixon, E. H. Strange, and E. Graham. The rate of propagation of an explosion in a gaseous mixture can be ascertained by photographing the flash, as it passes along a short glass tube, on a sensitive film revolving at a known rate, and then measuring the angle through which the image has been rotated. A number of photographs of this kind were exhibited. They reveal the existence of a second wave, which passes back along the tube in the opposite direction to the flash, and at a much slower rate. This wave is probably set up by the explosion wave when it reaches the end of the tube, and by measuring its velocity the authors are enabled to estimate the maximum temperature of the gases immediately in the wake of the explosion wave. The maximum temperatures, obtained with a number of different mixtures, lie between 3000° and 4000°, and are thus of the same order as those found by Bunsen, by Berthelot, and by Mallard and Le Chatelier for the temperature of the explosion itself.

Sir G. G. Stokes expressed the opinion that the luminosity which accompanied the reflected wave might be due, not to any chemical action, but to the temporary compression of the gases, which had only cooled slightly below their point of luminosity.

The only paper on the subject of the Röntgen rays which found its way into the Chemical Section was one in which Dr. J. H. Gladstone and Mr. W. Hibbert drew a contrast between the action of metals and their salts on ordinary light and on the new rays. All the metals, except in exceedingly thin films, are opaque to light, whilst their compounds with electronegative radicles—the metallic salts—are transparent, or only exhibit a selective absorption. With the Röntgen rays the relations are quite different. The metals exhibit all degrees of opacity towards these rays, lithium being almost transparent, platinum and gold practically opaque, whilst the opacity of the other metals seems to follow the order of their atomic weights. In the salts the metals seem to retain their own absorptive power, and the absorption of a solution of a salt appears to be the sum of the absorptions of the metal, the acid radicle, and the solvent.

A paper on the "Limiting Explosive Proportions of Acetylene, and Detection and Measurement of this Gas in the Air," was read by Prof. F. Clowes. The possibility of the introduction of acetylene as an illuminant renders a knowledge of these factors of considerable practical importance. The detection and estimation of the gas in air can be carried out by the well-known flame-cap test, so small a proportion as 0·25 per cent. being readily distinguishable. A convenient portable apparatus was exhibited for carrying out the test at any desired place. All mixtures of air and acetylene which contain from 3–82 per cent. of the latter are explosive, this being a wider range of explosibility than is shown by any other gas. Carbon is deposited during the combustion of all mixtures containing more than 22 per cent. of acetylene. In a later communication the author showed that the flame cap test can also be applied to the detec-

tion and estimation of carbon monoxide in air, with about the same degree of sensitiveness as with acetylene. A short note on "The Accurate Estimation of Oxygen by Absorption with Alkaline Pyrogallol Solution" was also read by Prof. Clowes.

Dr. A. W. Titherley, of University College, Liverpool, gave a short account of his work on the "Amides of the Alkali Metals and some of their Derivatives." The amides of sodium, potassium, lithium, and rubidium have been prepared in the pure state. They all readily dissolve the corresponding metal, forming blue solutions. Their melting points do not vary regularly with the atomic weight of the metal, since lithamide melts at 380–400°, sodamide at 155°, potassamide at 270°, and rubidamide at 285°. The potassium and sodium compounds do not yield the nitride when heated, as has been stated by previous investigators. Analogous derivatives of the alkyl amines have also been prepared, and promise to be of great interest.

Several communications on physical chemistry were received by the Section, the first of which was a paper by Prof. Oscar Liebreich, on "Diminution of Chemical Action due to Limitations of Space." Certain reactions take place much less readily near a liquid surface than in the interior of a liquid, and the author terms this region of diminished action the "dead space." This remarkable fact has led the author to the conclusion that liquid friction is of influence on the phenomena of chemical action, and that in small enclosed spaces—spaces in which the fluid is, as it were, solidified—the reaction is retarded.

Dr. Wildermann read a paper supplementing that which he brought before the Association at its last meeting on "The Velocity of Reactions before perfect Equilibrium takes place." For a number of cases of crystallisation of liquids and solutions he has now been able to obtain experimental evidence which establishes the complete applicability of the thermodynamic equation to the rate of reaction, as well as to provide a statical explanation for the well-known fact that the velocity of a reaction is independent of the amount of a solid substance present, which cannot readily be explained on kinetic grounds.

In a short note on "The Behaviour of Litmus in Amphoteric Solutions," Dr. T. Bradshaw opposed the view that the violet colour produced when a mixture of sodium dihydrogen phosphate with the ordinary disodium hydrogen phosphate is added to a solution of litmus is due to a special compound, probably an acid salt, of the litmus acid. The author considers that the violet colour is caused by the simultaneous presence of small amounts of blue and red litmus, the shade varying with the proportions of the two sodium salts which are present, whilst taken separately one of the salts has an acid, and the other an alkaline reaction to litmus.

Prof. Max Bamberger read a short paper on "Excrescent Resins," and described a number of crystalline substances which he had succeeded in extracting from them. Messrs. A. G. Green and A. Wahl contributed a paper on "The Constitution of Sun Yellow or Curcumine and allied colouring matters." These substances have been supposed by Bender to contain the azoxy-group $-\mathrm{N}\overset{\mathrm{O}}{\diagup\diagdown}\mathrm{N}-$, but this does not account for the great stability of the compounds towards oxidising agents, nor for the difficulty of reduction to diamidostilbenesulphonic acid. These properties are better explained by supposing that one of the nitrogen atoms is present as an azine group, whilst the other acts as a pentad and is combined with oxygen, the characteristic ring, $\begin{array}{l}\mathrm{C{=}NO{-}C}\\ \mid \qquad\quad \mid\\ \mathrm{C{=}N{-}{-}C}\end{array}$ being therefore present. It appears probable that oxyphenine, chloramine yellow, and other dyes have a similar constitution.

Dr. F. E. Francis read an interesting paper on "Abnormalities in the behaviour of Ortho-derivatives of Orthamido- and Orthonitro-benzylamine," in which he drew attention to the remarkable influence on the behaviour of certain compounds of the presence of substituted groups in the ortho-position. Thus, for example, whilst most of the derivatives of orthamidobenzylamine yield a triazine when treated with nitrous acid, no such compound can be obtained from the orthamidobenzyl derivatives of orthotoluidine, orthanisidine, and orthochloraniline. A number of other instances were also adduced.

In a paper on "Nitrates: their Occurrence and Manufacture," Mr. W. Newton, after describing the ordinary method of extracting sodium nitrate, drew attention to the fact that the rocky stratum overlying the caliche contains 15 to 20 per cent. of nitrate, and that, although this has to be broken through before the caliche can be removed, the whole of the nitrate in it is at present neglected. The total production of nitrate, which was only 58,000 tons in 1860, amounted to 1,218,000 tons in 1895.

Prof. Ramsay gave a detailed account of the very remarkable and abnormal properties of helium. When this gas is fractionally diffused through a piece of pipe-stem, it may be separated into two portions, which differ in density, one of them having the density 1·874 and the other 2·133. These two portions nevertheless show exactly the same spectrum when they are examined under the same conditions, the difference between the spectra of the two fractions, which was observed by Runge and Paschen, being due to a difference of pressure. The refractive indices of the two portions are directly proportional to their densities, whilst this relation does not hold for other gases. A further abnormality exists in the rates at which the two fractions diffuse. The relative rate of diffusion of each fraction, compared with hydrogen, is about 15 to 20 per cent. more rapid than that calculated from the density, according to Graham's law. No satisfactory explanation has yet been arrived at, and the author proposes to submit other gases to fractional diffusion, in order to see whether they also yield two fractions of different density. Such a result would seem to point to the conclusion that the atoms of any substance are not all alike in weight, but vary about an average value, as suggested by Crookes. In the discussion which followed, Prof. Dixon pointed out that Graham's law of diffusion is based solely on experiments made with gases composed of polyatomic molecules. The President suggested that, as both helium and argon have no chemical affinities, it is not extravagant to look upon them as the first examples of a new kind of matter, differing in many respects from ordinary matter.

Dr. F. Hurter, in a paper on the "Manufacture of Chlorine by means of Nitric Acid," touched upon a phase in the development of the chlorine industry which had only been lightly treated in the presidential address. The principle of all the methods proposed for this purpose is the decomposition of hydrochloric acid by nitric acid, with the ultimate production of an oxide of nitrogen and free chlorine. The oxide of nitrogen is then reoxidised to nitric acid, and the process thus rendered continuous. All the methods hitherto proposed for this purpose labour under the fatal disadvantage that the treatment involved necessitates the concentration of a very large amount of sulphuric acid, the expense connected with which is fatal to the economical conduct of the process. The great difficulty of finding a material which will withstand the strong acids employed was brought forward by Mr. E. K. Muspratt as a further objection to the process.

Prof. J. Dewar gave an interesting account of several points in connection with "Low Temperature Research." Owing to the relative pressures of oxygen and nitrogen in the air, these two gases, although possessing different boiling-points, condense at almost exactly the same temperature when air is cooled. The method employed for measuring low temperatures consists in using a system of five thermo-junctions, so arranged that three of them are kept at 0°, whilst the other two are of the same metals but in the inverse order, so that when one of them is cooled, the other must be heated in order to preserve equilibrium. The low temperature to be observed is thus balanced by a high temperature which can easily be read off. Helium appears to be less easily condensible than hydrogen, and, moreover, possesses an abnormally low refractivity and real molecular volume. It is a remarkable fact that fluorine, the most active of all the chemical elements, in these respects resembles helium, the least active of all. The ratio of the refractivity of hydrogen to that of chlorine is almost the same as that of helium to that of argon, and it is quite possible that a substance may yet be discovered which will be intermediate between these two elements, just as fluorine is intermediate between hydrogen and chlorine.

A new and convenient form of Schrötter's apparatus for the estimation of carbon dioxide was exhibited by Dr. C. A. Kohn, who also, in conjunction with Dr. T. L. Bailey, showed an aspirator worked by a small electric motor. Dr. J. Haldane gave an interesting demonstration of his colorimetric method of estimating small amounts of carbon monoxide in the air, which has recently been described in NATURE (vol. liv. p. 207). Chemists will be interested to learn that the continued inhalation of a small proportion of the gas is much more dangerous than the momentary reception of a large quantity of it into the

lungs. The best antidote is the inhalation of oxygen. Rapid motion almost always produces collapse when more than 30 per cent. of the blood has been saturated with the gas.

Chemical education formed the subject of no less than three communications to the Section, almost the whole of one sitting being devoted to this important question.

Sir H. E. Roscoe, in opening a discussion on "Chemical Education in England and Germany," laid emphasis on the necessity for a training in the methods of research for those who were to be the leaders of industry. He also pointed out that, although great industries have in the past arisen and are now developing in England, our manufacturers do not show the same appreciation of the value of a thorough scientific training as those of Germany. A further difficulty is offered by the inefficiency of many of our secondary schools. A number of speakers took part in the discussion, agreement with Sir H. E. Roscoe's position being generally expressed. Some difference of opinion existed, however, as to where the reform was to originate; many speakers being in favour of calling in parliamentary aid, whilst others advocated the gradual training of public opinion on the point.

The subject of "Science Teaching in Elementary Schools" was dealt with by Dr. J. H. Gladstone, on behalf of the Committee appointed to investigate this question. Continued progress is being made in the teaching of science subjects in elementary schools. The Committee is strongly of opinion that the time has come when the educational authorities should lay down a scheme of elementary experimental science to be taken by every scholar before he is allowed to specialise into the various branches of science. An all-important point is to train teachers to regard science teaching as a means of mental culture, and to teach accordingly.

In practical illustration of the requirements laid down in the last sentence of the report, Miss L. Edna Walter read a paper, in which she recounted her experience of the teaching of science in girls' schools. The system of instruction is practically a continuation of the kindergarten system, applied to elementary scientific notions. The children are taught by being made to perform, and even to originate, simple physical measurements and experiments, and are encouraged to form their own notes into books of reference. After passing through such a preliminary course, the children are introduced to a course in practical chemistry such as that suggested by Prof. Armstrong, or that adopted by the Association of Head Masters.

Several of the Committees of the Association presented important reports of the work carried out during the past year. Mr. C. F. Cross read the report of the Committee on "The Constituents of Barley Straw," The results obtained make it appear probable that the furfuroid constituents of the cereals are not, as has hitherto been supposed, secondary products of assimilation, but are directly built up by the plant. The furfuroids appear to form a very large group, comprising a number of different substances, which differ in their susceptibility to yeast, and yield osazones of different melting-points. The cereal plants are distinguished by the great proportion of grain which they produce, the amount being no less than 40 per cent. of the weight of the entire plant. It appears probable that during the period of production of seed, part of the necessary material is derived from the tissues of the stem and leaves.

Prof. Bedson presented the report of the Committee which has been engaged in the examination of the "Proximate Constituents of Coal." Ordinary coal is practically insoluble in all reagents, but can be converted by treatment with dilute hydrochloric acid and potassium chlorate into soluble products, the composition of many of which has been ascertained. By repeated treatment, no less than 75 per cent. of the coal can be dissolved. Brown coal appears to behave in a similar manner.

The Committee on "The Isomeric Naphthalene Derivatives" reports that work has now been begun on the important subject of isomeric change, especially in the sulphonic acids and other derivatives of the naphthols.

The report of the Committee on "Quantitative Methods of Electrolysis" is of very great practical value, and comprises four distinct papers. One of these deals with a very convenient arrangement of the necessary electrical instruments, whilst the others treat of the determination of bismuth, antimony, and tin. The separation of the last two can only be satisfactorily accomplished when there is less tin than antimony present.

The Committee on the "Action of Light on Dyed Fabrics" has also been active during the past year, a large number of dyed fabrics having been tested in this respect.

Advantage was taken of the favourable position of Liverpool to inspect several of the more important chemical works in the district.

GEOLOGY AT THE BRITISH ASSOCIATION.

THE President of this Section devoted his address mainly to stratigraphical geology, and we may well follow his example, and consider the papers presented to the Section in a similar order. Beginning with the oldest rocks, the first paper to claim attention is that by Sir W. Dawson, on pre-Cambrian Fossils. A valuable portion of this paper summarised our knowledge of the succession of Canadian rocks of high antiquity. He regards Matthew's *Protolenus* zone of New Brunswick as the equivalent of the *Olenellus* zone, and beneath this occurs a mass of greenish slates and conglomerates with a few doubtful fossils, such as brachiopods, ostracods, and protozoans. These Etcheminian rocks rest on the Huronian rocks, which contain worm-burrows, sponge spicules, and laminated forms comparable to *Cryptozoon* and *Eozoon*. Under these comes the Grenvillian system, or Upper Laurentian rocks, with *Eozoon* in the limestones, and at the base the orthoclase gneiss and hornblendic schists, which constitute the Lower Laurentian. The author exhibited a series of lantern slides showing the structure and composition of *Eozoon canadense*, amongst them being many very beautiful decalcified specimens, which none of those who criticised the paper attempted to explain.

Dr. G. F. Matthew's paper, which followed, endeavoured to recognise the larval characters of entromostraca, brachiopods, and trilobites in those faunas which preceded that of *Paradoxides*. He showed that in the young of trilobites from the *Paradoxides* beds the following larval characters were striking: (1) the predominance of the cephalic over the caudal shield; (2) the long, narrow, parallel-sided glabella; (3) the absence of eyes; (4) absence of movable cheeks; (5) absence or smallness of thorax; (6) the pygidium is at first small and of one segment. Such larval characters are to be observed in pre-Paradoxidian trilobites, and the author particularised *Ptychoparia*, *Solenopleura*, and the trilobites of the *Protolenus* fauna, such as the type-genus, *Ellipsocephalus*, and *Micmacca*. Similar conclusions were arrived at with regard to the Obolidæ, and to such ostracods as *Beyrichonia* and *Hipparicharion*.

Sir Archibald Geikie referred to some rocks, hitherto described as volcanic agglomerates, in Anglesey. Although the material of which the rocks were composed is volcanic, he now regards the brecciated and conglomeratic structure as due to earth-movement. The hard bands have been broken and rounded into fragments, the softer crushed and stretched out into a broken slate or phyllite.

Mr. Greenly dealt with a similar subject, and he referred to the quartzite lenticles, which about Beaumaris vary from one-quarter of an inch to one foot in length, but at Pen-y-parc attain a length of 700 feet, to the action of earth-movement. They were originally beds, but had been crushed and pinched off till they formed mere lenticles. The same author announced the discovery, in Central Anglesey, of bands of Sillimanite gneiss occurring where the gneiss is traversed by sills and bands of granite, to which there are no chilled edges. These Sillimanite gneisses are like those described by Mr. Horne and the author from Eastern Sutherland, where they are also associated with hornblendic gneiss of Hebridian aspect.

Ancient rocks of a very different character were dealt with by Mr. W. W. Watts, who gave some notes on his recent work in Charnwood Forest. The volcanic rocks had been mapped in detail on the six-inch scale, and the divisions correlated from one part of the country to another. Their age was still in doubt, but was not likely to be newer than Cambrian, while the unlikeness to the Cambrian system is shown at Nuneaton, and the direction of movement in the anticline pointed to a greater antiquity. A set of views was shown to illustrate the remarkable character of the scenery produced by the old rock, whose features dated back to pre-Triassic, and probably pre-Carboniferous, times. The old hills and valleys were beautifully preserved under a mask of Triassic marl, which was only now being slowly removed in places.

Messrs. Howard and Small made a very interesting communication on the rocks of Skomer Island, likewise illustrated

by views of the coast and microscopic slides shown by means of the lantern. Indeed, it is to be hoped that the use of the lantern will in future be encouraged by the Section; so many of the papers gained new interest and importance from the bringing into the room, so to speak, of the sections described by authors. Both igneous rocks and sediments were described; the former appeared to include rhyolites, often with magnificent nodular structure, and basalts, both occurring as lava flows with accompanying beds of tuff and ash. The age of the rocks appears to be about equivalent to the Bala or Llandovery rocks of the mainland. The microscopic aspect of the felsites, basalts, porphyrites, and clastic rocks was also described.

In his paper on the "Geology of the Isle of Man," intended as an introduction of the subject to those members who journeyed thither on the following Thursday, Prof. Boyd Dawkins dealt first with the Ordovician massif, its crush-conglomerates, slates, and grits; next he passed to the Carboniferous Limestone, which in the south is associated with lavas, ashes, and intrusive dykes. The red sandstone and conglomerates to the east of Peel he regarded as Permian, and not of Lower Carboniferous or Old Red Sandstone age. Four borings through the drift of the north part of the island were next described: one of these reached Triassic marls with salt, of which a total thickness of 33 feet had been penetrated; the other three reached Carboniferous Limestone at depths varying from 168 feet to 947 feet, two of them passing through Permian strata, and one through Yoredale sandstones and shales.

Mr. Garwood presented a report on the work on Carboniferous zones, containing a plan of campaign and a list of observers who had undertaken to collect carefully from each horizon of the rock, in order to ascertain whether it was possible to break up this great division on palæontological lines. Mr. G. H. Morton, in his paper on the distribution of Carboniferous fossils, did not give much encouragement to this Committee, for he showed that, taking what are at present regarded as species of brachiopods and mollusca, they appear to have a very wide range through the four main divisions of the limestone in Llangollen, Flintshire, and the Vale of Clwyd. In this paper he dealt with rare and common species, and showed that it was only the latter which would be of any real use in identifying zones, on account of the rarity and sporadic distribution of the former.

Passing to newer rocks, Mr. H. C. Beasley referred to footprints from the Trias in the neighbourhood of Liverpool. A slab of sandstone in University College contains about ninety-five prints in an area of about three square feet. Prints of webbed feet appear to be rare; a recently discovered footprint may belong to a chelonian. Other forms have been recently described by the author in a paper published by the Liverpool Geological Society. Mr. Morton described a boring near Altcar, which showed that the New Red Marl in this district was not less than 971 feet thick, but no salt or saline springs were met with. Another boring, on the west of Bidston Hill, showed only 454 feet of Red Marl, and 244 feet of Keuper sandstones; it then passed into a fault, and penetrated the upper soft sandstone of the Bunter from 133 feet.

Mr. Montagu Browne described the true bone-bed of Aust Cliff, and the *Pullastra arenicola* bed which occurs above it; the latter he considered to be the equivalent of the so-called bone-bed of Westbury and Penarth, but the bone-bed of the Spinney Hills in Leicester he considered to be the same as that of Aust, a suggestion which was strengthened by the occurrence of *Ceratodus* in both. *Sphenonchus*, hitherto recorded from the Lias, has now been found in the bone-bed at Aust Cliff and at the Spinney Hills. The third and final report of the Committee on the Stonesfield Slate gives the following corrected section through these beds:—

		ft.	ins.
Great Oolite	Limestone with corals ... ... Limestone and marls (oyster beds)	17	3
	Stonesfield Slate	5	3
Fullonian ...	Fawn-coloured (Chipping Norton) limestones, about	18	0
Inferior Oolite	Sandy limestones with some marl Lower limestones with vertical plant markings (Lower Estuarine Series	11	0
	Clypeus grit zone of *A. Parkinsoni*	13	0

About 12 feet of inferior Oolite strata can be made out below.

Mr. H. B. Woodward communicated some notes on sections along the London extension of the Manchester, Sheffield, and Lincolnshire Railway between Rugby and Aylesbury: Lower, Middle, and Upper Lias, Estuarine Beds, Great Oolite, Oxford Clay, and Boulder Clay are exposed in different cuttings; the agent which produced the last, had evidently been forced over a Great Oolite surface.

A large number of papers dealing with Glacial Geology were presented, and Monday was devoted to the discussion of them. The Erratic Blocks Committee reported that the Yorkshire Boulder Committee, and the Committees of Lincolnshire and of the Belfast Field Naturalists' Club had continued their systematic work. Special attention had been paid to the distribution of the Ailsa Crag rocks around the Irish Sea, to the Shap boulders down the Yorkshire coast into Lincolnshire and about Doncaster, and to the Norwegian erratics south and east from Staithes. A block of Shap granite had been found in the estuary of the Mersey. Mr. A. Bell described the Tertiary deposits of North Manxland, and attributed the shells in them to the period represented by the gravels of Wexford, Aberdeen, and Iceland; these are probably of Weybourn Crag age, and belong to the Pliocene period. Mr. Kendal gave an illustrated account of certain river valleys in Yorkshire which have changed their direction in part since the Glacial period. The Derwent flows west instead of east, the Swale and Wiske appear to have been formerly tributary to the Tees. The Nidd flows through a new gorge at Knaresborough and Plumpton, its old valley from Ripley past Brearton into the Vale of York having been dammed by drift, while the Wharfe has been similarly diverted into a gorge from Wetherby to Tadcaster; these diversions appear to have been due to drift deposited on the flank of a great eastern glacier. The same author, in conjunction with Mr. Lomas, described the glacial phenomena of the Clwyd Valley. There appears to have been no glacial submergence. The earlier drift seems to have been formed by Welsh ice, which was powerful enough to flow over even the Moel Fammau range; this was afterwards overpowered by ice bringing northern erratics, and compelled to divide into two streams, one of which escaped westwards by the Menai Straits; the other eastwards into the Midlands. Clay and shells like those of Lancashire occur in the northern part of the vale. Mr. J. Smith dealt with the marine shells in high-level drifts in Ayrshire, describing the order of succession, and giving a list of the shells, most of which are fragmentary. The Clava Committee described the shell-bearing clays in Kintyre, which had been investigated by borings carried out by the aid of grants from the Royal Society and the British Association. The wide extent of the clay was proved, a list of the shells given, and the composition and character of the deposit ascertained and accurately described. Dr. Callaway adhered to that interpretation of the superficial deposits of Shropshire, which attributes to them a marine origin. He laid special stress on their similarity to littoral deposits, their abundant marine fauna, and the ripple-marking so common in the sands. Chalk flints are abundant, and the author had found a Cornbrush fossil in the sands of Wellington. The hills and crags of the area do not present a glaciated outline.

The Hoxne Committee dealt with the very full exploration, undertaken by Mr. Clement Reid and his colleagues, into the palæolithic deposits of this place. They succeeded in establishing, by borings and excavations, that the boulder clay had been cut out into a valley of which no signs now appeared at the surface, as it had been filled with some remarkable lacustrine deposits in which plant remains had been found. The earliest of these indicated a temperate climate, the plant beds culminating in a bed of lignite. Succeeding these beds comes a black loam with the remains of arctic plants, and on the top of this is the sand, loam, and gravel in which palæolithic remains occur. No traces of human workmanship have yet been found beneath this upper layer, and hence the known human relics in this area are separated by two important climatic changes from the period of the boulder clay; the first from arctic to temperate, and the second back from temperate to arctic conditions. The work of this Committee appears to be well worthy of imitation, for it was undertaken and completed with great energy and a good deal of hard work within a year, and its results appear to admit of but one interpretation, that the human relics found here have nothing whatever to do with the Glacial period, with which they were once supposed to have been connected.

The last Glacial paper that we need notice is that by Prof. Hull, who suggested that the great uplift of the West Indian Islands might have contributed to cause the cold of the glacial

period by compelling the Gulf Stream waters to flow directly into the North Atlantic without passing into the Gulf of Mexico. By thus shortening its journey, the author calculated that the water would be delivered into the North Atlantic ten degrees colder than was at present the case. The author also referred to the amount of high land in the northern hemisphere as another contributing cause; and in both these suggestions he was supported by Sir William Dawson, who spoke in the discussion on the paper.

Mr. Mellard Reade gave evidence of land oscillation near Liverpool, derived from river-channels buried in drift, which itself often has an eroded surface covered by estuarine deposits, in turn overlaid by forest-beds made up of the remains of oak, Scotch fir, and birch; the latter are now just at the sea-level, or even a little below it. Three land surfaces appear to be present—one pre-glacial, the second post-glacial, and a third, still later, represented by the peat beds and submerged forests. Mr. Morton, dealing with the sea-coast of Wirral, showed that near the Leasowe embankment the sea had encroached 85 yards between 1871 and 1896, and at Dove Point the erosion was about 4 or 5 yards per annum from 1863 to the present. Mr. H. N. Ridley has not yet been able to begin excavations in the Singapore caves, but he has seen the white snake which inhabits them and is said to feed on bats: it is not blind, but has large eyes.

On the subject of Palæontology there is little to record, and in that of Petrology still less. Short interim reports were presented by the Eurypterid, Phyllopod, Moreseat, and Type Specimen Committees. Prof. Seeley described a skull of *Diademodon*, brought from Wonder Boom by Dr. Kannemeyer. The reptile possesses ten molar and premolar teeth, and its post-frontal bone differs from that of *Ornithorhynchus* in its different relation to the small brain cavity, and in contributing to form the circular orbit of the eye. Mr. Seward announced that *Glossopteris* and *Vertebraria* had been found near Johannesburg, associated with specimens of *Lepidophloios*. A similar association has lately been recorded by Prof. Zeiler in Brazilian plant-bearing beds.

Dr. Johnston-Lavis criticised the interpretation placed by Messrs. Weed and Pirsson in an igneous mass in the Highwood Mountains, Montana. Square Butte is a laccolite in Cretaceous sandstone, composed of an outer and upper layer of basic rock, called *Shonkinite* by them, and a core of syenite. Dr. Johnston-Lavis gave several reasons for supposing that the interpretation of this by differentiation on the spot was an error. Such differentiation would not result in a curved plane of separation, nor in the denser rock occurring at the top. He preferred to think the two rocks were separate intrusions, perhaps from the same magma originally, but that the upper part had been intruded first, and had acquired its basic character by absorption in passing through limestone or other basic rock walls. By the time the later intrusion of the syenitic magma took place, the rock walls had absorbed so much silica that little further change in its composition occurred. Dr. Busz recorded the discovery of corundum as a product of contact metamorphism on the southern flank of the Dartmoor granite, and amongst other minerals described the occurrence of cassiterite inside crystals of andalusite similarly produced.

A number of papers dealing with problems in physical and dynamical geology were presented. Prof. Seeley described the occurrence of false bedding in clays of Reading age, and also in similar rocks of Wealden date. Mr. Logan Lobley gave evidence to show that lava could not be derived from any great depth down in the earth's crust, and also that the shrinking of the globe since Cambrian times was a practically negligible factor in the contortion of rocks. Dr. Walther inquired, in general terms, whether evidence of fossil deserts was not likely to be obtained in the geological record. The Coral Boring Committee had to record that, in spite of two attempts, the site chosen for the operations, Funafuti in the South Pacific, had proved unsuitable; a mixture of quicksand with great coral blocks resisted all attempts made to bore through it. Time had not allowed of the transfer of apparatus and observers to another island, and consequently the project had been abandoned. Much good observational work in zoology and anthropology had, however, been carried out by the members of the expedition.

Mr. Vaughan Cornish illustrated the different types of ripple-marking produced by the sea (symmetrical and knife-edged), by streams (symmetrical and rounded), and by wind (unsymmetrical). Mr. Wethered gave an account of the general character of the ocean depths at different geological epochs, alluding mainly to the chief types of lime-secreting organisms found in each great limestone mass. He described with lantern illustration many of the encrusting organisms, such as *Girvanella* and *Mitcheldeania*. Mr. Kendal pointed out the effects of solution on organisms with aragonite, and on those with calcite shells; he concluded that the readier solution of the former was the cause of the bathymetrical limit defining the extent of Pteropod ooze. In a separate communication the same author concluded that the disappearance of aragonite shells from the Upper Chalk, and the preservation of calcite organisms, argued that this rock was deposited at a depth of at least 1500 fathoms, a conclusion supported by Dr. Hume and Mr. Jukes-Browne from entirely different standpoints. Prof. Milne gave a minute report on his seismological observations during the year in the Isle of Wight. His instruments enabled him to feel the larger earthquakes at great distances, even right through the earth. From his observations on August 31, he concluded that there must have been a violent earthquake at some spot about 6000 miles distant from his observatory; a distance which probably indicates that the site of the earthquake was Japan. News of such a shock has been received, but of its intensity we at present know nothing.

It only remains to notice that the Photographs Committee recorded about 200 new geological photographs as received during the year; but that still many portions of the British Isles are woefully ill-represented in the collection which, although now lodged at Jermyn Street, still hopes to receive marked increases during the next few years.

GEOGRAPHY AT THE BRITISH ASSOCIATION

The Geographical Section was perhaps more largely attended at Liverpool than at any previous meeting of the Association, a result due in some measure to the convenient situation and beautiful construction of the large hall set apart for its meetings, and also due in part to the numerous lantern exhibitions of photographs of little-known regions. The number of papers and reports read was thirty-four, considerably more than usual, and meetings were held on five days. It was impossible, owing to the private arrangements of the gentlemen who read papers, to arrange for a proper classification of the work of the various days, and, therefore, in the following notes the strict order of the papers is not followed.

The presidential address, by Major Darwin, dealing with the scientific principles by which the development of Africa for commercial purposes should be directed, was particularly adapted for the place of meeting, on account of the very close relations between Liverpool and West Africa. Mr. G. F. Scott Elliot, in a communication on the influence of African climate and vegetation on civilisation, made an effort to generalise on the same subject from a different side. He divided Africa into four regions: (1) *The wet jungle*, which is marked roughly by the presence of the oil or coconut palm, numerous creepers—especially the Landolphia (rubber vines)—and such forms as Sesamum, *Cajanus indicus*, and Manhihot as cultivated plants. This region is characterised by great heat and continuous humidity, without a season sufficiently dry to leave a mark on the vegetation. (2) *The deserts*, characterised by xerophytic adaptations, by Zilla, Mesembryanthemum, *Capparis sodada*, &c. The climate is distinguished by possessing no proper rainy season whatever. (3) *The acacia and dry grass region*, characterised by acacias, tree euphorbias, giant grasses, or frequently grassy plains in which each tuft of grass is isolated. The climate is marked from all the remaining regions by distinct dry and wet seasons; the dry season occupies from five to nine months, and leaves a distinct mark on the vegetation. This region occupies practically all Africa between 3000 feet and 5000 feet, and also extends below 3000 feet wherever the above climatic conditions prevail. (4) *The temperate grass and forest area* is distinguished by having at no season of the year such drought as leaves a permanent mark on the vegetation, by a moderate rainfall, by moderate heat, &c. The grass resembles the turf of temperate countries, and the forest shows the same sorts of adaptation as occur in temperate countries. This region is found between 4600 feet and 7000 feet. Of these regions the wet jungle is everywhere inhabited by small tribes of a weak enfeebled character, and in the lowest stage of civilisation. The desert, on the contrary, is the home of exceedingly healthy and vigorous tribes. The Acacia region is everywhere rather densely populated, but no emigrations in

large numbers have taken place from it. The temperate grass and forest regions above 5000 feet are the only places in Africa that have acted as swarming centres of population. The character of the native races inhabiting them is vigorous and turbulent, and raiding is often carried on. The differences in climate, vegetation, and abundance of wild and domestic animals, explain why it is that these races only have, except in one instance, resisted both Arab and European.

Sir Charles Wilson gave an able and most timely discourse on the geography of the Egyptian Sudan, dwelling especially on the resources of the country, and the importance of opening out trade-routes between the Sudan and the sea: the best method of doing which appeared to him to be the construction of such a line as the Berber and Suakin railway. Lieut. Vandeleur read an interesting account of his recent journey from Uganda to the Upper Nile country, giving an excellent idea of the physical geography and resources of the region, and dwelling in particular on the difficulties to navigation caused by the floating vegetable carpet or *sudd* which frequently blocks the rivers. Amongst other slides he showed the first photographs which have been taken of the Murchison Falls on the Victoria Nile. The Rev. C. H. Robinson gave an account of his experiences amongst the Hausa in the Niger district; and Mr. H. S. Cowper gave some account of a second short journey made in March 1896, in the Tarhuna and M'salata districts of Tripoli. During his visit he examined or noted about forty additional megalithic ruins of the type called by the Arabs Senam. The route taken was by the Wadi Terr'qurt, a fine valley running parallel to the Wadi Doga, by which he entered the hills in 1895. He then proceeded to the districts of Ghirrah and Mamurah, south of Ferjana, through which runs a great wadi, the Tergilat. This reaches the sea at Kam, twelve miles south-east of the ruins of Leptis Magna, and is undoubtedly the Cinyps of Herodotus. On reaching the coast a week was spent at the ruins of Leptis and the Kam district, and the return journey was made to Tripoli by sea.

The Committee on African Climatology (President, Mr. E. G. Ravenstein; Secretary, Mr. H. N. Dickson) presented a full and satisfactory report, giving abstracts from twelve stations in tropical Africa. In recognition of the useful work done by this Committee, it was reappointed with a small grant.

Next to Africa the Arctic regions naturally commanded a large share of the attention of the Section. Preliminary accounts of three expeditions were given. Mr. J. Scott Keltie, who had just returned from taking part in the Norwegian welcome to Dr. Nansen, described his impressions of the explorer and his companions, gave an outline of the work they had done, laying special stress on Prof. Mohn's high estimate of the value of the meteorological and magnetic observations, and announced that Dr. Nansen would probably visit this country in November in order to give a full account of his great journey before the Royal Geographical Society. Mr. Montefiore Brice gave an interesting report on the progress of the Jackson-Harmsworth expedition, and showed by the lantern a number of photographs taken in Franz Josef Land, including some of the arrival of Dr. Nansen at Mr. Jackson's headquarters. He stated that next year it was probable that the expedition would be reinforced by two ships to push forward exploration in the sea north of Franz Josef Land. Sir W. Martin Conway described his experiences in crossing the interior of Spitzbergen last summer, the soft condition of the snow and the marshy character of the land having interposed obstacles which could not have been foreseen from the observations of earlier travellers. Mr. Frederick W. Howell and Dr. K. Grossman exhibited a number of striking pictures of the scenery of little-known parts of Iceland, the former dealing mainly with glacial, the latter with volcanic forms.

Other descriptive papers, in all cases admirably illustrated, were contributed by Mr. W. A. L. Fletcher, on his journey across Tibet from north to south, on which he accompanied Mr. and Mrs. St. George Littledale; by Mr. H. W. Cave, on the ruined cities of Ceylon; and by Mr. A. E. FitzGerald, on his crossing of the Southern Alps in New Zealand. Mr. FitzGerald announced that he was about to a lead a party to the Southern Andes, where he hoped to make the first ascent of Aconcagua.

Sir James Grant gave an eloquent address on the gold discoveries in Canada, and Mr. E. Odlum, of Vancouver, described the contested territories on the borderland of British Columbia and Alaska. These papers attracted the greater attention on account of the approaching visit of the British Association to Toronto. Mr. Ralph Richardson initiated a short discussion on the boundary lines in British Guiana, attributed to Sir Robert Schomburgk.

The geography of the British Islands was not lost sight of at the meeting. The Rev. W. K. R. Bedford described some old tapestry maps of parts of England, woven at Weston in the last quarter of the sixteenth century, now preserved in the Bodleian Library at Oxford, and in the Chapter-house at York. They are on the scale of about four inches to one mile, and show some features which do not appear on the maps in contemporary atlases. Dr. H. R. Mill called attention to his scheme for a geographical memoir to accompany the maps of the Ordnance Survey, on a specimen of which he is now at work. Dr. Gulliver, of Harvard, gave an interesting discussion of the coast-forms of Romney Marsh, dwelling on the origin of the cuspate foreland of Dungeness, and pointing out the importance of treating such problems according to the genetic cycle. Mr. B. V. Darbishire showed by a series of maps of the South Wales coal-field, how the physical structure of the country controlled the distribution of population, and the construction of lines of communication.

There were several papers dealing with physical geography. Mr. John Coles gave a demonstration of two methods of photographic surveying, exhibiting the cameras used for each. He expressed his conviction that photographic methods were bound to take a very important place indeed in the surveys of the immediate future. Prof. J. Milne discussed earthquakes and sea-waves, with special reference to recent occurrences in Japan; and Mr. H. N. Dickson gave a short account of the work which he has in progress on the temperature and composition of the water of the North Atlantic. Mr. A. J. Herbertson exhibited some of a series of maps of the mean monthly distribution of rainfall for the world, which he is at present engaged in compiling, in collaboration with Dr. Buchan. They present the facts of the distribution of rainfall for the first time in a form admitting of the study of seasonal variations.

Mr. Vaughan Cornish contributed one of the most valuable and original papers read to the Section, in the form of a practical study of the formation and distribution of sand-dunes. He said that in the sorting of materials by wind the coarser gravel is left on stony deserts or sea-beaches, the sand is heaped up in dune tracts, and the dust (consisting largely of friable materials which have been reduced to powder in the dune district itself) forms widely-scattered deposits beyond the limits of the dune district. Three principal factors operate in dune tracts, viz. (1) the wind, (2) the eddy in the lee of each obstacle, (3) gravity. The wind drifts the fine and the coarse sand. The upward motion of the eddy lifts the fine sand, and, co-operating with the wind, sends it flying from the crest of the dune. The backward motion of the eddy arrests the forward drift of the coarser sand, and thus co-operates with the wind to build the permanent structure of the dune. Gravity reduces to the angle of rest any slopes which have been forced to a steeper pitch either by wind or eddy; hence in a group of dunes the amplitude cannot be greater than (about) one-third of the wave length. This limit is most nearly approached, owing to an action which the author explained, when the wind blows alternately from opposite quarters. Gravity also acts upon the sand which flies from the crests, causing it to fall across the stream lines of the air. To the varying density of the sand-shower is due the varying angle of the windward slope of dunes. When there is no sand-shower the windward becomes as steep as the leeward slope. When the dune tract is all deep sand the lower part of the eddy gouges out the trough, and, when the sand-shower fails, the wind by drifting and the eddy by gouging, form isolated hills upon a hard bed. In a district of deep sand, negative dunes ("Suljes") may be formed. The encroachment of a dune tract being due not only to the march of the dunes (by drifting), but also to the formation of new dunes to leeward from material supplied by the sand-shower, it follows that there is both a "group velocity" and a "wave velocity" of dunes. Since the wave velocity decreases as the amplitude increases, a sufficiently large dune is a stationary hill, even though composed of loose sand throughout. Where material is accumulated by the action of tidal currents, forms homologous with the ground plan of dunes are shown upon the charts. The vertical contours and the movements of subaqueous sand dunes are conditioned by the different tactics of sand-shower and sand-drift.

The educational aspect of geography was brought forward on

several occasions. The interim report of a Committee on Geographical education in this country appointed last year was read; the material collected by its Secretary (Mr. Herbertson) is very voluminous, but being still incomplete, its final consideration was postponed until next year. Mr. Herbertson also showed an ingenious piece of apparatus designed to explain the theory of map projections by a shadow of a skeleton hemisphere made up of wire meridians and parallels thrown on a sheet of paper by a candle, the position of which can be varied by sliding it along a bar. Mr. A. W. Andrews, of Malvern Wells, gave a thoughtful paper, from the standpoint of a practical teacher, on the importance of combining geographical and historical teaching in schools. A very similar subject was treated, with philosophic thoroughness, by Mr. G. G. Chisholm, under the title of "the relativity of geographical advantages." In his opinion geographical advantages may be considered: (1) As relative to the physical condition of the surface of a country, *e g.* the extent of forests, marshes, &c. The former and present relative importance of Liverpool and Bristol may be explained, in part at least, by changes that have taken place under this head. Also the difference in direction by some of the great Roman roads and those of the present day, and the consequent fact that some important Roman stations in Britain are not now represented even by a hamlet. (2) As relative to the political condition of a country and of other countries. (3) As relative to the state of military science. Under these two heads the difference in the situation of the Roman wall between the Tyne and Solway and the Anglo-Scottish boundary suggests some considerations. Also the difference in the situation of some important Roman towns or stations and their modern representatives (Uriconium, Shrewsbury; Sorbiodunum, Salisbury). (4) As relative to the state of applied science—well illustrated in this country in the history of the iron and textile industries. (5) As relative to the density of population—another impotrant consideration in the industrial history of our own country. (6) As relative to the mental attitude of the people where the geographical advantages exist. Many Chinese travellers and students of China have recognised the excessive reverence for ancestors in that country as one great hindrance in the way of turning the advantages of the country to account.

Taken altogether the proceedings of Section E show that geography, viewed as a science, is in a progressive and healthy condition in Great Britain at the present time. Increased attention is being devoted to the theoretical aspects, while there is certainly no diminution in the enterprise of explorers or in their power of conveying a clear idea of the new lands and seas they visit.

SCIENCE IN THE MAGAZINES.

DURING the last twenty or thirty years there has been a very large increase in the number of insane under detention in asylums. This increase, Mr. Thomas Drapes argues with much force in the *Fortnightly*, is mainly due to accumulation of chronic cases, and does not in itself necessarily indicate any increase in insanity in the sense of increased liability to mental derangement on the part of the community. In fact, the number of insane under care could double itself in the course of a comparatively short period of years without the addition of a single case to the number of those annually attacked. For these reasons, and because lunacy statistics only show a rise of 0·3 per 10,000 (from 4·5 to 4·8) of first admissions in twenty years, Mr. Drapes holds that no alarming increase has occurred in liability to insanity in England.

Twelve months ago, Dr. A. R. Wallace brought together, in the *Fortnightly*, a number of interesting facts which seemed to show that mouth-gesture was the chief factor in the origin of language. He pointed out that a considerable number of the most familiar words are so constructed as to proclaim their meaning more or less distinctly by movements of various parts of the mouth used in pronouncing them, and by peculiarities in breathing, or in vocalisation. Mr. Charles Johnston meets Dr. Wallace on his own ground by asking him, in this month's number of the *Fortnightly*, the purport of a quatrain of which two lines are:—"Jambvâmralodhrakhadira—sâlavet rasamâkulam, Padmakamalakaplaksha—kadambodumbarâortam." This is a part of a highly-coloured description which has been the admiration of centuries, and Dr. Wallace is invited to declare the meaning it expresses. But Mr. Johnston does not confine himself to setting conundrums; he shows how very difficult it is to reach any fixed principle on the lines laid down, how extremely fugitive and contradictory the expressiveness of words is. It is suggested that more sound conclusions as to the beginnings of language will be derived from the study of "The World's Baby-Talk." Just as embryology has shown that each individual climbs up his own genealogical tree, so, by watching the development of speech in a baby, we can see the first steps in articulate language. Mr. Johnston elaborates this idea, and shows that certain languages, chosen for their extreme phonetic simplicity, exhibit a striking analogy with baby-talk.

A third article in the *Fortnightly* is by Mr. H. G. Wells, and the title is "Human Evolution, an Artificial Process." Starting from well-known biological facts, suggestive conclusions in ethics and educational science are reached. "Assuming the truth of Natural Selection," says Mr Wells, "and having regard to Prof. Weismann's destructive criticisms of the evidence for the inheritance of acquired, there are satisfactory grounds for believing that man (allowing for racial blendings) is still mentally, morally, and physically, what he was during the later Palæolithic period, that we are, and that the race is likely to remain, for (humanly speaking) a vast period of time, at the level of the Stone Age. The only considerable evolution that has occurred since then, so far as man is concerned, has been, it is here asserted, a different sort of evolution altogether, an evolution of suggestions and ideas." Taking the average rate at which rabbits breed, something like two hundred generations would descend from a single doe in a century, and would be subjected to the process of Natural Selection, whereas only four or five human generations would be amenable to the same process in the same time. "Taking all these points together, and assuming four generations of men to the century—a generous allowance—and ten thousand years as the period of time that has elapsed since man entered upon the age of Polished Stone, it can scarcely be an exaggeration to say that he has had time only to undergo as much specific modification as the rabbit could get through in a century." The difference between civilised man and the Stone Age savage arises from the development of speech and writing, so that, to follow the argument, civilised man represents (1) an inherited factor, the natural man, who is the product of natural selection, and (2) an acquired factor, the artificial man, the highly plastic creature of tradition, suggestion, and reasoned thought. Obviously, then, education should aim at the careful and systematic manufacture of the latter factor.

An article by Mr. W. K. Hill, in the *Contemporary*, may be taken as an expression of the general opinion that the development of the "artificial factor," referred to by Mr. Wells, is not carried out on intelligent lines. "In the secondary school the great Scholarship Steeplechase is the chief occupation. In the university the spirit of examination, like a huge cuttle-fish, is gradually winding its multiple tentacles around every effort at original thought and ideal culture." Geometry is studied, says Mr. Hill, as an abstract concatenation of puzzles, instead of as a means to educate the faculty of reasoning. "We teach always, but seldom educate, and yet 'Instruction,' as Locke truly observes, is but the least part of education. We do not try to develop mind—we only try to stuff brain." But while men of science have regretfully to confess that the indictment has much evidence to support it, they may point, at the same time, to the growth of a better system of instruction in many of our schools and colleges—a system which makes the pupil investigate for himself natural phenomena and laws, and develops his faculties of observation and reasoning.

From mediæval history Mr. Boris Sidis has drawn a number of instances of mental epidemics which spread from one end of Europe to the other, and left thousands of people struggling in convulsions of hysterical insanity, and performing acts as if their voluntary movement had been lost, or greatly limited. To this class of mental epidemics belong the pilgrimage mania, Crusade mania, and dancing manias. These epidemics, and others, are described in the *Century*. In experiments in suggestion made by Mr. Sidis in the Psychological Laboratory at Harvard College, he found that when the attention, in perfectly normal people, was concentrated on one point for some time, say twenty seconds, commands suddenly given at the end of that time were very often immediately carried out by the subjects. Concentration of attention upon one point appears, therefore, to be highly favourable to suggestibility, and Mr. Sidis is of the opinion that—"The mediæval man was in a similar state of light hypnosis. This was induced in him by the great limitation of his voluntary movements, by the inhibi-

tion of his will, by the social pressure which was exerted on him by the great weight of authority to which his life was subjected. . . . Bound fast by the strings of authority, mediæval men were reduced to the state of hypnotic automata" All the conditions were thus favourable for the production and wide extension of mental epidemics. Mr. Sidis thinks that these epidemics, religious manias, political plagues, speculative insanities, financial crazes, and economical panics, from which society in general, and democracy in particular, continually suffer, point to the extreme suggestibility of gregarious man.

Another article in the *Century* is the third paper made up of extracts from the journals of the late Mr. E. J. Glave, and it offers some very interesting glimpses of a part of the journey of this young explorer from the mouth of the Zambesi diagonally north-west across Central Africa to the mouth of the Congo.

The new series of *Science Progress* begins with the October number. Mr. G. J. Symons traces the early history of scientific weather forecasting in the new number; and Mr. Alfred Harker surveys some of the modern aspects of petrology in relation to igneous rocks, only considering in the present paper the distribution of the rocks in time and space. In a paper on recent work upon visceral and allied nerves, Dr. T. Gregor Brodie gives a long account of the present state of knowledge of the subject. Some brief notes on parasites are contributed by Mr. A. E. Shipley. Dr. K. Gœbel deals with "Teratology in Modern Botany," discussing in his paper the origin of malformations, and the bearing of these upon the problems of the origin of the organic forms. Prof. Sydney J. Hickson writes on "The Nervous System of Cœlentera," and Mr. A. C. Seward on "Palæobotany and Evolution."

Attention may profitably be called to a few general articles in the reviews. Dr. George M Dawson, Director of the Geological Survey of Canada, writes on "Canada as a Field for Mining Investment," in the *National*. In the *Contemporary*, Mr. J. Allanson Picton discusses the Report of the Vaccination Commission, and the same review contains a narrative of travel in Sumatra, by Mr. Claes Ericsson.

Among the popular articles on scientific topics in the magazines received are the following:—Mr. W. H. Hudson, in *Longman's*, writes enthusiastically on the song of the wood-wren, with the laudable object of attracting more attention to that somewhat obscure bird. *Chambers's Journal* contains an article on after-damp in coal-mines, based upon Dr. Haldane's Blue-Book on the explosion at the Tylorstown Colliery in South Wales.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—Prof. Bradbury has been appointed assessor to the Regius Professor of Physic; Prof. Allbutt, F.R.S, an elector to the Downing Professorship of Medicine (Pharmacology); Prof. Macalister, F.R.S., an elector to the chair of Zoology and Comparative Anatomy; Sir G. G. Stokes, F.R.S., and Prof. Darwin, F.R.S., electors to the Isaac Newton Studentship in Physical Astronomy; and Mr. H. M. MacDonald, of Clare, with Mr. G. T. Bennett, of Emmanuel and St. John's, moderators in the Mathematical Tripos o f1897.

Mr. W. S. Adie, bracketed senior wrangler in 1894, and Mr. E. T. Whittaker, bracketed second wrangler in 1895, have been elected to fellowships at Trinity College; Mr. H. S. Carslaw, bracketed fourth wrangler in 1894, has been elected to a studentship of £120 for advanced study and research.

The new regulations for advanced study and research appear to have become widely known and appreciated. Over a score of "advanced students" have already been admitted to the several colleges, and have commenced their post-graduate courses in a large variety of departments, scientific and literary.

A fire has destroyed the main building of Mount Holyoke College, including all the dormitories, and involving a loss of 100,000 dollars.

The lamp of science is to shed its beams (through lantern slides) in East London this winter The Rev. H. N. Hutchinson will lecture at the Whitechapel Free Public Library Museum, on November 10, upon "Extinct Monsters," and on December 8, Mr. G. R. Murray will discourse upon "The Meadows of the Sea." Admission to the lectures is free by ticket, to be obtained in the Museum and Lending Library.

The following awards of entrance exhibitions and scholarships in medical schools have been announced:—King's College: Sambrooke exhibitions of £60 and £40, respectively, to Arthur Edmunds and W. W. Campbell; Warneford Scholarships of £25 each for two years, to J. A. Drake and C. J. Galbraith. Charing Cross Hospital Medical School: Livingstone Scholarship, 100 guineas, Mr. C. Jerome Mercier; Huxley Scholarship, 55 guineas, to Mr. F. B. Pinniger; Epsom Scholarship, 110 guineas, Mr. L. C. Badcock; University Scholarships, 60 guineas each, Mr. H. S. Clogg and Mr. R. J. Willson; Entrance Scholarships are also awarded to Mr. W. B. Blandy, 60 guineas, and Mr. Charles H. Fennell, 40 guineas.

The following are among recent announcements:—Dr. H. Minkowski, professor of mathematics in the University of Königsberg, has been called to the Zürich Polytechnic Institute; Prof. Erismann has, for political reasons, had to resign the chair of Hygiene in the University of Moscow; Mr. F. B. Loomis to be assistant in biology, and Mr. E. S. Newton assistant in chemistry at Amherst College; Mr. P. C Nugent to be instructor in civil engineering, and Mr. R. E. Dennis to be instructor in chemistry at Lafayette College; Miss A. M. Claypole to be instructor in zoology, and Miss J. Evans instructor in botany at Wellesley College; Miss M. E. Maltby has been appointed acting professor of physics at the same college during the absence of Miss S. F. Whittinghead.

A provisional Committee has been formed to obtain funds and make the preliminary arrangements to establish a county museum for Hertfordshire. Earl Spencer has generously offered a site in St. Albans adequate to the erection of the proposed museum, on the conditions that a representative body of the county and of St. Albans were favourable to the scheme, and that sufficient funds to erect and maintain it were raised. The Committee hope to raise a sum of about £5000, about £3000 of which should be expended upon a building and fittings, and the remainder be invested as an endowment fund. It is suggested that when completed, in order to secure perpetuity to the museum, it should be vested in the hands of the County Council, and its management given to a Committee chosen from representatives of the County Council, the Hertfordshire Natural History Society, and the St. Albans Architectural and Archæological Society, and other gentlemen interested in the Arts, sciences, and archæology of the county.

The Cheshire Agricultural and Horticultural School has just been formally opened. The County Council have secured Saltersford Hall, and farm of 100 acres, on a lease of forty-two years, and have spent £10,000 in the requisite alterations and additions, stocking the farm and garden, and furnishing the house and school. The hall will provide accommodation for sixty students with the necessary teaching staff. A schoolroom, laboratory, lecture room, and workshops have been built and furnished with all the essentials of a large educational establishment. Three glass-houses will be devoted to the growth of grapes, peaches, nectarines, and similar fruit. There are also three other detached greenhouses, and these are to be utilised for the cultivation of tomatoes, melons, flowers; while an orchard has been planted to provide instruction in fruit culture. A herd of fifteen or sixteen cows will be kept, comprising Ayrshires, Jerseys, and Herefords, in order to bring under the attention of the students the merits of various breeds. It is intended that the College shall afford means for a thorough practical and technical training for students of agriculture and horticulture.

Speaking on Saturday, at the opening of the new session of University College, Liverpool, Sir William Priestley said: "One of the most striking features in the organisation of the several colleges comprising the Victoria University is the great and laudable generosity and public spirit displayed by local benefactors, who have subscribed largely to endow them with appliances for successful teaching. I believe there is latent public spirit in London, but if it exists it does not take so distinct a form. What is everybody's business becomes nobody's business, and great institutions like University and King's College are languishing for want of funds, while the provincial colleges find generous benefactors concentrating attention upon them, and giving endowments and donations which are the envy of their metropolitan sisters. Government aid is urgently needed

both in the London and provincial colleges, in view of the increased cost of scientific education and the necessity of making it as cheap as possible to the students. It is the Government aid in Germany and elsewhere on the continent which enables the great teaching institutions there to compete at such advantage with the universities and colleges of this country, and to outdistance them in scientific and industrial products."

Students of the Royal College of Science, South Kensington, have reason to be proud of the heritage to which they have succeeded. Huxley took the greatest interest in the College, with which he was connected until his death; and there he introduced the system of teaching which has revolutionised the methods of training in biology. Prof. J. W. Judd dwelt upon this fact in the course of an address delivered to the students of the College on Wednesday in last week, and his words should make them all feel that they are connected with a great institution, whose interests they should watch over, and whose position they should endeavour to sustain, by keeping the aims and work of their late noble Dean in view. Five years has yet to elapse before the College celebrates its first jubilee. Nevertheless, if the students remember how recent has been the recognition of that culture in which scientific training takes a leading part, as distinguished from that derived from purely literary pursuits, they may indeed be proud of the position which the College occupies. The prizes and medals won in the College this year were distributed as follows:—Royal Scholarships: First year's, J. W. Barker, C. E. Goodyear, E. R. Verity, and E. T. Thomas; second year's, W. H. White and E. Smith. The Edward Forbes' Medal for Biology, E. C. Horrell; the Murchison Medal for Geology, E. E. L. Dixon; Tyndall Prize for Physics, E. T. Harrison; Bessemer Medal for Mining, J. Crowther; and Frank Hatton Prize for Chemistry, G. T. Morgan.

The Technical Education Board of the London County Council are evidently determined to provide instruction for all the sorts and conditions of men and women in the metropolis. We are glad to see the completeness of the arrangements they have made for the present winter. The most exacting critic will surely find it difficult to point to any class of the community which has been forgotten. The perusal of recent numbers of the *Technical Education Gazette* shows that the workers of London can have the benefit of instruction from the leading professors of the metropolitan colleges at merely nominal fees—for nothing indeed, in not a few cases. At the Central School of Arts and Crafts, the teaching will be specially adapted to those employed in the different parts of the building trades, for workers in glass, bronze, and lead, enamellers, and the various branches of the gold and silver trades. No attempt will, however, be made, to meet the requirements of the amateur. It must be noted that there is no lack of attention to the necessity of providing a sound scientific foundation on which to build up a particular technical knowledge. The advanced evening science classes, which are being held both at University and King's Colleges, will be of immense value, and it will be a cause for the profoundest regret, if these courses are not well attended. It will soon be impossible to find any part of London where there is no thoroughly equipped and properly staffed technical school, and such a fact speaks volumes for the energy and wisdom of the Board's advisers.

SCIENTIFIC SERIALS.

Symons's Monthly Meteorological Magazine, September.—The first daily weather map, sold in the Great Exhibition of 1851. Mr. Symons publishes a reduced copy of a series of such maps issued daily from August 8 to October 11, 1851, Sundays excepted, indicating the conditions of the atmosphere in several parts of Great Britain at 9h. a.m. Twelve years later, in September 1863, M. Le Verrier issued his weather maps from the Paris Observatory, which are now continued in an extended form by the Paris Meteorological Office.—Dry periods. On August 1, Mr. Symons wrote to the *Times*, pointing out that at Camden Square, London, the rainfall of the first seven months of this year (8·27 inches) is only 60 per cent. of the average for the thirty-seven years 1859-95; during the ten years 1887-96 the average for the same period was only 11·65 inches, while for the twenty eight years 1859-86 it was 14·24 inches. Commenting on this, Mr. J. M. Fraser, of Lochmaddy, Hebrides, states that the average rainfall for the first eight months of the twelve years 1884-95 is 27·78 inches, and the average for the same period in 1890-95 was 30·11 inches, while this year the total for the first eight months is 34·86 inches. It is noteworthy that the deficiency in the south of England should be made up by a heavy yearly increase in the opposite extreme of the kingdom.

The papers of most general interest in the numbers of the *Journal of Botany* for August, September, and October are:—On the new genus of Commelynaceæ (*Spatholirion*), from the Malay Peninsula, by Mr. H. N. Ridley, with a plate; on the displacement of species in New Zealand, by Mr. T. Kirk, especially the crowding out of native species by naturalised plants, and the changes caused by cultivation, the introduction of parasitic diseases, and other human agencies; on Algæ from Central Africa, by MM. W. and G. S. West, with illustrations, and diagnoses of several new species of desmids; on new or critical marine Algæ, by Mr. E. A. L. Batters; a revised list of the British Caryophyllaceæ, by Mr. F. N. Williams; with continuations of Mr. Rendle's paper on African Acanthaceæ, including diagnoses of many new species, and of a new genus *Lindauea*: and of Dr. Schlechter's on African Asclepiadeæ.

SOCIETIES AND ACADEMIES.

Manchester.

Literary and Philosophical Society, October 6.—Prof. Osborne Reynolds, F.R.S., Vice-President, in the chair.—Prof. F. E. Weiss communicated a paper on *Rachiopteris cylindrica*, by the late Mr. Thomas Hick. The name of Rachiopteris was given by Williamson to some plant remains from the Lower Coal Measures of Halifax, which he thought might be true ferns, and described in the *Philosophical Transactions*, 1878. Mr. Hick describes in detail some further specimens, partly belonging to the Cash Collection at Manchester Museum. In considering the cortical tissues, special reference is made to the presence of small black bodies within the cortical cells, the presence of which is characteristic for Rachiopteris, but the nature of which is still very doubtful. Considerable attention is paid to the division of the stele, as indicating the dichotomous manner of branching; and mention is made of the presence at the points of bifurcation of endogenous organs, probably of the nature of roots. From the knowledge of the anatomical details, Mr. Hick concludes that Rachiopteris cannot possibly be a root, but is probably a stem or leaf structure of a plant having more affinity with the Filices than with the Lycopodiaceæ.—On the structure and contents of the tubers of *Anthoceros tuberosus*, by J. H. Ashworth. The tubers of *Anthoceros tuberosus* are described in Gottsche's "Synopsis Hepaticarum" as oval bodies containing a farinaceous mass within a deeply-coloured envelope. The author finds that these tubers, which lie beneath the thallus, and are connected to it by a stalk, have a wall formed of three or four layers of corky cells, some of which are produced into hair-like processes. Within these protective layers lie closely-packed cells containing granules and fluid oil drops. The granules are not starch, but give all the reactions for proteids, and appear to be aleurone grains. Besides these stalked tubers there are similar tuberous masses formed in the thallus, which have not been previously described. These, which are rather smaller in size than the tubers, are formed between the upper and lower layers of the thallus, and are composed of cells exactly like the inner cells of the stalked tubers. The tubers may be regarded as gemmæ, in which the inner cells have become stored with food material, and are protected by the corky layers against being dried up, *Anthoceros tuberosus* being found on the banks of the Swan River in Western Australia, where it is exposed to severe drought.

Paris.

Academy of Sciences, October 5.—M. A. Chatin in the chair.—Researches on the explosive properties of acetylene, by MM. Berthelot and Vieille. Details of experiments carried out with a view of seeing what precautions, if any, are necessary in the preparation, compression, and storage of acetylene for commercial uses. It has been known for some time that the decomposition of acetylene by a heated wire, by mercury fulminate, or by the electric spark, is not propagated any considerable distance if the gas is under atmospheric pressure. At pressures of two atmospheres and over, however, the decomposition is complete, the explosive pressure produced rising so rapidly with the initial compression, that the effects produced by detonation of the liquefied gas resemble those of ordinary explosives.—Remarks

on an experiment of M. Birkeland, by M. H. Poincaré. A mathematical study of the deflection of the kathode rays by means of a magnet.—On the infections caused by the bacilli of the *Proteus* group, and on the agglutinating properties of the serum in these cases, by MM. Lannelongue and Achard.—The truffles of Greece: *Terfezia Gennadii*, by M. Ad. Chatin. Three specific types have been found in Greece: *Terfezia Claveryi*, *Terfezia Gennadii*, and *Terfezia Leonis*.—Correction to a preceding note on the homogeneity of argon and helium, by Profs. W. Ramsay and J. N. Collie. (See NATURE, October 8, p. 546.)—The cave of La Mouthe, by M. E. Rivière. This note, the fifth on this subject, deals with the drawings on the sides of the cave. There seems to be no doubt of the great antiquity of these drawings, many being covered up with stalagmitic deposits.—On algebraic systems, and their relations with certain systems of partial differential equations, by M. H. E. Delassus.—On the region within which a summation of Taylor's series is possible, by M. E. Borel.—Antistaphyloccic serotherapy, by M. Capman. With the filtered toxines from staphyloccus cultures, dogs were successfully rendered immune; the serum from these dogs, taken about three weeks after the injection, amply protected the rabbit and the guinea-pig against a toxic injection. The curious fact was established, that shortly after injection in the dog there was a temporary increase in toxicity, the serum taken two days after the commencement of the fever being five times the toxic strength of the toxine inoculated.—On beans, by M. Balland. A study of the physical and chemical properties of beans of various origins. Analyses are given showing the composition of the whole bean, the skin, and the cotyledons with the germ.—Neuro-psychosis, by M. Boukteieff.

New South Wales.

Linnean Society, August 26.—P. N. Trebeck in the chair.—On the Australian *Bembidiides* referable to the genus *Tachys* (fam. *Carabidæ*), with the description of a new allied genus, by Thomas G. Sloane.—Descriptions of two new species of *Prostanthera*, from New South Wales, by R. T. Baker.—Eucalypts and Loranths in their relations of host and parasite, and as food-plants, by J. J. Fletcher. The object of this paper was mainly to evoke discussion on a subject which is not devoid of interest. The propositions brought forward may be summarised as follows:—Even a cursory investigation of the relations subsisting between some of the most characteristic forms of Australian vegetation—*e.g.* Proteads, Acacias, and Eucalypts—and the animals (more particularly insects) to which they serve as food-plants, shows a state of affairs in harmony with Mr. Wollaston's axiom "that the most peculiar insects of a region are usually to be found either dependent on or inhabiting the same area as its most peculiar plants" (*Trans. Ent. Soc.* (3), i. 1862-64, p. 136). Among the plants mentioned, the Eucalypts, in point of both variety and number of the species dependent upon them, stand conspicuously first; being preyed upon by a goodly assemblage of forms, including phytophagous mammals, insects of almost every order—phytophagous, xylophagous, juice-feeding and gall-making, not to speak of anthophilous forms—as well as Phytoptids. Nor is it merely individual plants that suffer; for there are not wanting recorded instances in which species have been locally threatened with xtinction by reason of the depredations of phalangers, coleoptera, lepidopterous larvæ, phasmids, &c. Eucalypts have now become extensively acclimatised in other parts of the world, where, by way of contrast to the state of things sketched above, it is interesting to know that on the whole the attitude of insects towards them is one not of indifference merely, but in some cases even of positive antipathy. In cases like that of the Laurel- and Euphorbia-infesting animals referred to by Mr. Wollaston, and the Eucalyptus-infesting animals of Australia, the opinion was expressed that the adaptation of the animals to their food-plants—which contain more or less abundant stores of chemical substances ordinarily distasteful to animals—was one requiring a long period of time for its acquirement, and for the development of hereditary tastes; perhaps also the stimulus of stern necessity. As to whether, as has been supposed, the association of Loranths and Eucalypts is to be looked upon as a case of mimicry, it was pointed out that the association is at most—over and above any gain accruing from parasitism—but of partial and local benefit to the former; that in times past it was profitable; but that now, on the whole, it is a possible case of true mimicry in the later stages of becoming bankrupt and played out.

DIARY OF SOCIETIES.

London.

TUESDAY, October 20.

Royal Photographic Society, at 8.—Half-tone direct from Nature: Wm. Gamble.

WEDNESDAY, October 21.

Entomological Society, at 8.—New Hymenoptera from the Mesilla Valley, New Mexico: T. D. A. Cockerell.—A Monograph of British Braconidæ, Part vii.: Rev. T. A. Marshall.

Royal Microscopical Society, at 8.—Photo-micrographic Camera designed chiefly to facilitate the Study of Opaque Objects: J. Butterworth. On the Occurrence of Endocysts in the Genus Thalassiosira: T. Comber.—On the Measurement of the Apertures of Objectives: E. M. Nelson.

BOOKS AND SERIALS RECEIVED.

Books.—A Sketch of the Natural History of Australia: F. G. Aflalo (Macmillan).—The Elements of Electro-chemistry; Prof M. Le Blanc, translated by W. R. Whitney (Macmillan)—Notes of the Night, &c.: Dr. C. C. Abbott (Warne).—The Romance of the Sea: F. Whymper (S.P.C.K.). Peasblossom: C. Pridham (J. Heywood).—An Egyptian Reading-Book for Beginners: Dr. E. A. W. Budge (K. Paul).—Elementary Geology: Prof. G. S. Boulger (Collins).—University College, Bristol, Calendar 189⁶-7 (Bristol, Arrowsmith).—Die Principien der Wärmelehre: Dr. E. Mach (Leipzig, Barth).—Examples in Electrical Engineering: S. Joyce (Longmans).—Stanford's Compendium of Geography and Travel (new issue) Asia, Vol. 2, Southern and Western Asia: A. H. Keane (Stanford).—A Text-Book of Bacteriology: Prof. E. M. Crookshank, 4th edition (Lewis).—Diagrams of Terrestrial and Astronomical Objects and Phenomena: R. A. Gregory (Chapman).

Serials.—Internationales Archiv für Ethnographie, Band ix., Heft 4 (Leiden. Brill).—Reliquary and Illustrated Archæologist, October (Bemrose).—Essex Institute Historical Collections, Vol. xxxii. (Salem, Mass.).—Strand Magazine, October (Newnes).—Journal of the Royal Statistical Society, September (Stanford).—Lloyd's Natural History—Birds, Parts 5 and 6: Dr. R. B. Sharpe (Lloyd).—American Journal of Science, October (New Haven).—Science Progress, October (Scientific Press).—Engineering Magazine, October (Tucker).—Zeitschrift für Wissenschaftliche Zoologie, lxii. Band, 1 Heft (Leipzig, Engelmann).—Annals of Scottish Natural History, October (Edinburgh, Douglas).—Papers and Proceedings of the Royal Society of Tasmania for 1894-95 (Hobart).—Journal of Physical Chemistry, No. 1 (Ithaca, N.Y.; London, Gay).—American Journal of Mathematics, Vol. xviii. No. 4 (Baltimore).—Mind, October (Williams).

CONTENTS.

THURSDAY, OCTOBER 22, 1896.

THE BRITISH MUSEUM CATALOGUE OF CORALS.

Catalogue of the Madreporarian Corals in the British Museum (Natural History). Vol. II. *The Genus Turbinaria, the Genus Astræopora.* By Henry M. Bernard. 4to. Pp. 106; 33 plates. (London: 1896.)

THE first volume of the "Catalogue of the Madreporarian Corals in the British Museum" appeared in 1893; it consisted of a monograph of the very intricate genus *Madrepora*, and was the last work of the enthusiastic and talented George Brook. His lamented death threatened to seriously retard the production of the remaining volumes of the catalogue, for the Madreporaria are a peculiarly difficult group to classify, and as Dr. Brook had by that time obtained a considerable experience in the classification of corals, it was expected that he would have been able to bring out the succeeding volumes with a reasonable degree of celerity. Dr. Günther was fortunate enough at this juncture to secure the services of Mr. H. M. Bernard, who entered upon his laborious duties with characteristic energy and ability.

In the volume before us Mr. Bernard describes two genera which are allied to the one already catalogued. In the genus *Madrepora*, the free-swimming larva, on settling down, develops into an axial polyp, which gives off numerous tiers of daughter polyps, any one of which may become in its turn an axial polyp, giving off again numerous tiers of daughters, and so on.

In *Turbinaria* there is but one true axial polyp, which gives off only one ring of daughter polyps; these themselves bud, and their buds again bud, and so on. The daughter polyps may perhaps be considered as axial polyps which give off imperfect rings of buds, and these again parts of other rings of buds. Owing to this concentric budding in a single plane, a plate is formed, on the upper side of which the calicles alone occur. According to the angle at which the buds arise, so will the general expanse be cup-shaped or flattened; typically the corallum is salver-shaped, but owing to irregular growth the edges may become frilled, and eventually a complicated foliaceous mass, with more or less erect, irregularly fusing fronds may result. Sometimes the coralla form horizontal, dish-like growths, each fresh growth covers the previous one with a larger and thicker layer, there often being a space or fissure left between the two growths; or the corallum thickens enormously in the centre by the lengthening of the polyps, while the margin hangs down, each new growth creeping over the one which preceded it. In all cases the original axial polyp is submerged by subsequent growth. The downward streaming of the cœnenchyme not only thickens the stalk of the corallum, which may even be obliterated, but it tends to fill up the base of the hollow of the cup; this downward streaming leaves characteristic striations. Owing to the mode of growth, the Turbinarians are purely cœnenchymatous corals, the epitheca has dropped out of the skeleton except where it develops as a secondary epitheca on the under sides of fronds, especially where they tend to touch the surface upon which the cord is growing. The whole corallum is built up of the porous cœnenchymatous walls of the individual polyps, without any trace of epithecal envelopes, or of regular thecæ. Hence the term Athecalia, which has been proposed for such corals by Dr. Ortmann. Fifty-eight species of the genus *Turbinaria* are described by Mr. Bernard, of which some forty are new to science.

The only account we have of the structure of the soft parts of a Turbinarian is by Dr. G. H. Fowler (*Quart. Journ. Micro. Sci.*, xxviii. p. 1). The polyps have the usual two pairs of directive mesenteries; the lateral pairs of a particular polyp are not always equal in number. The septa arise only between pairs of mesenteries, as probably also do the tentacles. Nematocysts are evenly distributed over the tentacles. Zooxanthellæ are abundant in the superficial portions of the polyps and corallum.

In *Astræopora*, as in *Madrepora* and *Turbinaria*, the epitheca is extremely reduced. The genus *Astræopora* may be described as consisting typically of glomerate cœnenchymatous corals, in contrast, on the one hand, with *Madrepora*, which consists typically of branched, and on the other with *Turbinaria*, which consists typically of foliate cœnenchymatous corals. There is no definite system of budding, as in the other two genera, the colonies range in form from flat expanses to globular masses. The septa are very feebly developed. Fourteen species are known, of which nine are now described for the first time.

Mr. F. Jeffrey Bell had previously alluded (*Journ. Roy. Micro. Soc.*, 1895, p. 148) to the variations observed in large masses of *Turbinaria*, and his remarks are illustrated by a couple of excellent photographs. Those who have attempted to identify corals will also have experienced a feeling of dismay when confronted with variations in the form of coralla composed of apparently similar polyps, or of the vagaries of calicles on the same corallum. Often has the museum naturalist anticipated Mr. Bernard's question, "Is any classification of the various forms composing a genus into separate clearly-defined species possible?"

The following remarks by Mr. Bernard are worthy of the attention of systematists in other branches of zoology, and of those who interest themselves with the problems of variation.

"The only specimens which can be claimed with absolute certainty as specifically identical, are a few which have in each case been gathered at the same place and time, and resemble one another as closely as if they were two fragments of one and the same stock. Beyond these no certainty exists, and strict regard to the variations of form and structure would compel us to label all the remaining specimens as different species or varieties. Further, I do not remember ever having seen a specimen in other private or public collections which exactly recalled any single specimen in the British Museum. Are all these to be classed as new species? Such a course is only possible when the collection dealt with is very small; but when the number of specimens is measured by hundreds, one's courage fails. Hence recourse is had to a recognised but hardly satisfactory system of grouping: certain striking and conspicuous specimens (or single specimens which have already been described by previous workers) are selected as types, and the remainder are divided according as, in the opinion of the individual

worker, they approach one or the other of these favoured specimens. The types are thus in the highest degree arbitrary and accidental, as is also, it must be confessed (though in a less degree), the selection of other specimens to be associated with them.

"It seems to me certain that we are rapidly nearing the time when our ever-increasing collections, revealing as they do the infinite grades of variation presented by living organisms—especially by stock or colony-forming animals, such as corals, in which the varying factors are doubled—will compel us to break loose from the restraint of the Linnean 'species.'"

Finally, the book is well printed, and the thirty collotype plates admirably illustrate the *facies* of the coralla. Mr. Bernard has wisely added three lithographic plates in which are represented carefully drawn details of a typical calicle of most of the species.

OUR BOOK SHELF.

A Compendium of General Botany. By Dr. Max Westermaier. Translated by Dr. Albert Schneider. Pp. x + 299. (New York: John Wiley and Sons. London: Chapman and Hall, Ltd., 1896.)

In this book Dr. Westermaier has attempted to present an account of plants based on the lines indicated some years ago by Schwendener. But so far as English students are concerned, we cannot help thinking that he has rather fallen between two stools. The beginner, on the one hand, will find the book somewhat too advanced for his use; whilst on the other, a student who has already acquired some knowledge of the science, will discover that in the methods of dealing with some parts of his subject, Dr. Westermaier is rather one-sided. Thus, in discussing the factors operative in effecting the ascent of sap, a sketch is given of the views advocated by the author and by Schwendener, almost to the exclusion of those of other investigators; and we certainly cannot accept the conclusions as affording an "authoritative final explanation" of the process.

Notwithstanding, we are ready to admit that the book possesses some good points, and that it is interesting and even suggestive in places. But it scarcely deserves the somewhat ambitious title of "Compendium of General Botany."

The Testimony of Science to the Deluge. By W. B. Galloway, M.A. Pp. viii + 166. (London: Sampson Low, Marston, and Co., Ltd., 1896.)

It is impossible to treat this book seriously. Such as it were common enough forty or fifty years ago, but we had hoped they had gone the way of the dodo. They are compounded after the following recipe: To the narrowest views in theology, add a general ignorance of the principles of inductive reasoning, collect a number of scraps from scientific books, mainly those written when geology was in its infancy, or if not, carefully separated from their context; stir all together into a hopeless confusion, and serve up with a sauce of pious intention flavoured by some inappropriate quotations from Scripture. Mr. Galloway is one of the stalwarts; he will be content with no local deluges; he will not let us off a square yard of the flood's extent, or a foot of its depth, except perhaps in equatorial regions. This cataclysm produced the rounded and scored rocks, the perched blocks and the boulder-clays with the scratched stones. But he does not explain to us why these products of a universal deluge are restricted to certain parts of the earth, and what were its leavings in districts where our so-called glacial deposits are wanting. A deluge, however, must have a cause. So Mr. Galloway finds this in a sudden shift of the earth's axis of rotation, amounting to about $18\frac{1}{3}°$; and he unearths some speculations by Dr. Halley, fully two centuries old, in support of his hypothesis. He tells us also much about terrestrial magnetism which does not seem particularly applicable, but we find no explanation of what caused the shift, no proof that the resulting disturbances of water would be powerful enough to transport heavy rock masses in an open country—particularly when it is admitted that the axis may not have "jumped" from one position to the other, but that "several rotations of the earth would probably take place in the progress of the change." Mr. Galloway cannot even cite his authorities accurately. J. Evans (now Sir John) becomes T. Evans, G. F. Browne's Ice-caves becomes Brown's Icy Caves, and so on. But it is waste of time to criticise this book. We present its author at parting with a motto which might have been printed appropriately on his title-page—"Deferar in vicum vendentem thus et odores, Et piper, et quicquid chartis amicitur ineptis." T. G. B.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Utility of Specific Characters.

Absence from England has prevented my taking part in the discussion on this subject. At this stage I only desire to say that I quite agree with Prof. Ray Lankester, as I stated at the meeting of the Linnean Society, with respect to the contention that the specific characters of the systematist are not necessarily those upon which natural selection has directly acted in bringing about the specific differentiation. These external visible or measurable characters may be, and I believe often are, the outward expression of internal differences of constitution with which the external characters are correlated. In entering the lists at this late period, I am, however, mainly prompted by an omission on the part of Prof. Weldon to strengthen his own case by an argument which appears to me to be quite legitimate. The point at issue is whether the results of his laborious and, in my opinion, most valuable measurements of crabs, are to be interpreted as demonstrating the action of selection, or simply as revealing a law of growth. It might be imagined that if the latter alternative proved to be the correct interpretation, the case for selection falls to the ground. I do not take this view of the work, and, as a member of the Royal Society Committee concerned with the investigation, I am glad of the opportunity, afforded by the discussion in these columns, of giving expression to the idea which I have always entertained on this point, for whatever that idea may be worth. If future observation should show that there is no selection at work upon the young stages, weeding out the individuals whose breadth of carapace falls below a certain standard, but (according to the alternative) that the individuals get broader as they grow older, then it appears to me that the measurements may still be interpreted as indicating the action of selection; only the selection would have done its work in the past history of the species, instead of acting now, as on the original assumption. In other words, breadth of carapace (or some character correlated with it) had a selection value in the phylogeny; now this character appears at a late stage in the ontogeny. It is for Prof. Weldon to decide, by further observation, which of these interpretations is to be accepted. R. MELDOLA.

A Note on the Tesla Sparkand X-Ray Photography.

A Crookes' radiometer was supported by its stem about four inches above the hand, which was placed upon a photographic plate enclosed in two light-tight cases. The terminals of a Tesla coil were placed about half an inch from the bulb on either side of it, inclined to one another at an angle of 120°, the vertex of the angle being in the axis of the radiometer. The Tesla discharge was allowed to bombard the bulb for four minutes. On development a clear picture of the bones in the hand appeared. The experiment shows that the X-ray photo can be produced when an exhausted bulb is used having no terminals.

I failed entirely to get any X-ray results when only the usual induction sparks bombarded the bulb, these sparks often destroying the vacuum. My Tesla apparatus gives a spark three inches long in air at normal pressure. The mica radiometer vanes after many experiments lost nearly all the black substance with which they were coated; it appeared in the form of a deposit on the inside of the bulb, and it was deposited in the form of concentric circles, the centres of which were situated exactly opposite to the ends of the pointed conductors attached to the Tesla coil.

Thinking that the mica vanes in the Crookes' radiometer might have played a considerable part in producing the X-ray photograph, I replaced the radiometer by a well-exhausted bulb 4 c.m. diameter, made of soda glass; the bulb was placed with respect to the conductors from the Tesla coil in the same position as the radiometer in the former experiment. I found that with the same exposure and distance, a good X-ray photograph of the bones in the hand was produced. During the experiment the bulb was lit up with a bright and yellowish green glow. Since the Tesla discharge rapidly produces ozonised air which is irritating to the nose, throat and lungs, it is best to place the terminals in a draught of air moving away from the operator.

Oxford, October 17. FREDERICK J. SMITH.

Siemens's Domestic Gas Fire.

HAVING reference to the request, in your number of September 17, for information on this subject, it is worthy of remark that the chief feature in Sir William Siemens's invention, namely the general idea of using gas to aid the ordinary fire (instead of applying it merely to heat inert material), is capable of much simpler, cheaper, and more extensive application than it has yet met with. Some such gas-aided fires, which have answered well, will be found described in the *Builder* of October 26, 1889. Their only difference from the ordinary household fire consists in the introduction of a few common gas jets among the fuel, which may be either coal or coke, or, preferably, a combination of the two.

The same idea may be applied in other ways. I lately saw, in an artist's studio, a "gas torch," which was attached to a flexible tube, and thrust between the bars when wanted. And Prof. Ramsay, in a recent lecture, has proposed another ingenious contrivance with the same object. In any case, the easy command which the gas gives over the general management of the fire is a great domestic convenience. Its only drawback is a temptation to indulge in a somewhat lavish gas consumption. W. POLE.

Athenæum Club.

The Variable Star Z Herculis.

IN the issue of NATURE for October 1, a note appears on the above variable, containing some important remarks on the general practice of smoothing curves, and rejecting outstanding observations. I fully agree with Mr. Yendell, that by carrying out this practice unduly, much valuable information may be lost. During eleven years' continuous observations of long-period variables, I have not rejected a single observation, and my light curves are produced by simply plotting down the observations (each of which is the mean of five comparisons with stars of known magnitude) on a squared form, and joining the dots by straight lines. The result has been to abundantly prove the existence of very many secondary and minor variations, both in the rise and fall of nearly all the stars under observation.

Specially marked instances of complex variation of light curve occur in the cases of R Aurigæ, T Ursæ Majoris, R Draconis, and S Cephei. In many cases the magnitudes and dates of maximum and minimum are very wide of the predictions; and I am forced to the conclusion, arrived at in the case of Z Herculis, "that the period of these stars must evidently be variable, though the character and value of the variation cannot at present be determined." CUTHBERT PEEK.

Rousdon Observatory, Lyme Regis, October 12.

"Eozoon Canadensa."

ONCE more the long controverted point as to the organic origin of this remarkable body was brought before Section C at the meeting of the British Association at Liverpool, by that indefatigable naturalist, Principal Sir William Dawson, Montreal, and which, as on all former occasions when brought before a scientific audience, provoked considerable discussion both for and against. Amongst others, Prof. Bonney took part. There is one remark that he made, which I beg of you to allow me to emphatically contradict, *i.e.* that the late Dr. Carpenter had been deceived by the geologist who sent him sections of the specimens from the West Highlands of Scotland. It was the writer of the present note who sent the sections referred to, and he thought of contradicting the assertion of Prof. Bonney at the time, but conceived it would be a gross abuse of politeness, not only to Sir William Dawson, but also to the members of the Section, to take notice of a matter so foreign to the subject under discussion, and also from the conviction that Prof. Bonney must have been misinformed. This is like the old story of the three black crows which, from being black as a crow, got metamorphosed into three black crows, feathers and all. The correspondence with Prof. Carpenter and others is lying before me, but at present I shall simply give a copy of my own letter that accompanied the specimens, and which I hope will satisfy Prof. Bonney and others that there is no truth in the assertion that I deceived Prof. Carpenter, or any of the other naturalists who believed that the structure was of organic origin. JAMES THOMSON.

6 Stuart Street, Shawlands, Glasgow, October 2.

(*Copy of letter referred to.*)

April 22, 1876.

DEAR SIR,—You did me the honour, nearly two years ago, to send me a type specimen of *Eozoon Canadensa*, in order that I might know the characters of that fossil organism if I should discover anything like it in the Highlands of Scotland. Since then I have been through part of Argyllshire, Inverness-shire, Ross-shire, Sutherlandshire, and Caithness-shire, and have at last discovered in the neighbourhood of Tarbert Harris what seems to me to be organic structure; and the fact that the rocks of that district have been described by Sir R. Murchison and others as being of Laurentian age, suggests that the enclosed specimens have some little interest, and more especially after the article that appeared in the *Annals* of last month. [I then gave a list of the names of the geologists and naturalists who had examined the specimens, all of whom, with one exception, pronounced the structure to be of organic origin. These names I forbear to introduce at present, but will give the latter part of the letter.] The parent rock is found interstratified with a dark grey shale. About ten feet to the south of this section there is some very beautiful graphic granite *in situ*: a suite of the specimens of which I procured. None of the graphic granite shows the beautiful structure that is seen in the intercellular spaces of the enclosed. The outer margin of the mass from which the enclosed is obtained approximates in external aspect to some of the varieties of graphic granite, suggesting the problem: What is graphic granite? May it not be a highly metamorphosed organic body? the enclosed being less metamorphosed, hence the preservation of the organic-like structure. Such seems to me probable, but not having seen the graphic granites from other localities, I cannot give an opinion, and will leave the solution of the problem in your hands, and shall be pleased to hear your opinion at your earliest convenience.

I am, faithfully yours,
(Signed) JAMES THOMSON.

To Prof. W. B. Carpenter, M.D., F.R.S., &c., London.

The Departure of the Swallows.

LORD HOBHOUSE's observations with regard to the "swallows," would lead one to suppose that all the birds would have gone away south before now; but yesterday I saw two swallows and three martins hard at work flying about. This may not be very late for the martin, but surely it is quite an unusual date for the swallow, though White of Selborne records having seen them as late as November 3, but does not say anything about the martin. He adds to his record, "None [swallows] have been observed at Selborne since October 11." E. P.

Newnham.

Wasps and Flies.

MANY years ago I was in a country butcher's shop, and saw several wasps occupied in cutting out and carrying off small chunks of meat. (Kidney was most in demand, as being "short" in texture.)

I pointed out the marauders to the butcher, and was told that he was always glad to see wasps in his shop, as they kept the bluebottles away. E. H.

October 17.

BARON SIR FERDINAND VON MUELLER.

NEWS of the death of this distinguished botanist and geographer reached London on the 10th inst., causing some surprise, as it was not known here that his health was failing. Born at Rostock in 1825, and educated at Kiel, he emigrated to Australia in 1847, in consequence of hereditary symptoms of phthisis; having previously lost his parents. Mueller belonged to the school of botanists, now fast diminishing in numbers, who began their studies in the field instead of in the laboratory. Before leaving Europe, he devoted much time between 1840 and 1847 to the investigation of the flora of Schleswig-Holstein. On his arrival in Australia, he took service as a druggist's assistant in Adelaide—a post he seems to have held for a brief period, as he was soon engaged in exploring South Australia. From 1848 to 1852 he travelled at his own expense. At this date he was appointed, by Governor La Trobe, to the newly-created post of Government botanist, and soon visited the previously unexplored Australian Alps. About this period he entered into correspondence with the late Sir William Hooker, which led to the publication of the results of his earlier journeys in Hooker's *Kew Journal of Botany*, beginning with the fifth volume. In 1854 the Victorian Institute was founded[1]—the first institution of its kind, I believe, in Australia proper, though Tasmania had its Royal Society some three years earlier; and Mueller was one of the first and most prolific contributors to its *Transactions*. It was here that he published the new plants collected in the Australian Alps.

In 1855–56 Mueller was attached as botanist to Gregory's expedition across North Australia, from the Victoria River to the Albert River. In 1857 he was appointed Director of the Melbourne Botanic Garden; but in 1873 he was superseded, owing to his too rigidly scientific management, though he still retained charge of the herbarium and library. Great as were his exertions and his enthusiasm on the introduction and cultivation of useful and ornamental plants, he failed from a practical standpoint. His work on "Select Extra-tropical Plants eligible for Industrial Culture," &c., was an extraordinary success; yet not on account of its practical value, for it has none, but as a work of general reference it is very useful. Nine editions have appeared, including an American, a French, and a German edition.

During the forty-nine years of his Australian life, Mueller was such an unceasing and copious writer, that it is impossible to do more than glance at some of his more important publications. It was from the first his ambition to write a "Flora" of the entire country, and his almost innumerable papers were written with that view; but when it came to the point, the task, for various reasons, was confided to the late George Bentham, and Mueller most cordially co-operated with him by sending his collections and notes to Kew. Of that I can speak with some authority, having acted a very humble, though congenial, part in connection with the earlier volumes of the classical "Flora Australiensis." Mueller, however, found enough to do in publishing the thousands of novelties collected by himself, and by others under his direction. His "Fragmenta Phytographiæ Australiæ" is the chief, but by no means the sole repertorium of his descriptions. Prominent among his more utilitarian works are the illustrated monographs of the genera *Eucalyptus* and *Acacia*. His "Census of Australian Plants," so carefully compiled with regard to dates, references and authorities, is exceedingly useful for purposes of comparison with the floras of other countries, and has been extensively used by the writer and others. But Mueller was much more than a botanist and geographer; he was always a promoter, and often the originator, of movements for the scientific, social, and material welfare of the country he had made his home. He was in turn President of the Philosophical Institute, of the Geographical Society (Victorian branch), of the Australian Association for the Advancement of Science, and various other bodies and societies. He has also the reputation of having been a most devout and philanthropical person. And, in spite of his not being a practical horticulturist, he did more probably than any other person to promote the commercial—that is to say, the useful—development of cultural industries in Australia, and more than any other person in the diffusion of useful Australian plants in other parts of the world. He had probably a wider correspondence than any living botanist, and few are the establishments that have not been in some way benefited by him. The value of his work consists largely in the fact that he did exactly the kind of work that was required in a young country for its material as well as its moral development. It is true that his work exhibits more industry than genius; but, after all, what he undertook gave little scope for the latter quality. There was, however, a weak side in his character, which it would be affectation to pass over entirely, though one would say as little about it as possible. He had an inordinate craving for titles, distinctions, and admiration. This led him to publish, in all sorts of places and languages, what it would have been much better to have kept together, and to indulge in vagaries in botanical nomenclature which are simply deplorable and damaging to his character as a sincere servant of science. Nevertheless, the country to which he devoted nearly half a century of active life was proud of him, and justly so, and willingly honoured him during his lifetime, and will doubtless long cherish his memory.

W. BOTTING HEMSLEY.

[1] Subsequently the Philosophical Institute, and then the Royal Society.

NOTES.

OUR American contemporary, *Science*, suggests the formation of an International Association for the Advancement of Science, recent events having shown that members of the various national Associations regard co-operation in a cordial manner. The British Association meets in Toronto next year, and the American Association, after meeting at Detroit, on the Canadian frontier, will adjourn to Toronto to welcome our Association to the American continent. Another instance of community of feeling is afforded by the decision of the British Association to meet at Dover in 1899, in order to promote an interchange of visits between its members and those of the French Association, which will meet at Boulogne in the same year. These signs of fellowship indicate that the time has come when an international congress for the advancement of science may be profitably considered. Among the many subjects which would benefit by international co-operation are bibliography, nomenclature, definition of units, exploration, and science teaching. The amalgamation would also impress the collective weight of science upon the outside world, and would thus be able to claim a more adequate support and recognition of scientific progress. The proposal of our contemporary is that the first meeting of an international congress of this character should take place in Paris in the first year of the twentieth century. In considering the question of the amalgamation of Associations for the Advancement of Science, it must be remembered that great international congresses are often too unwieldy to be satisfactorily managed, and that the confusion of tongues at such gatherings is a constant factor working against success.

SCIENCE has just lost two of its foremost workers. We refer to Dr. Henry Trimen, F.R.S., late Director of the Royal Botanic Gardens, Ceylon, who died at Peradeniya on Sunday

last, in his fifty-third year; and M. Tisserand, the distinguished Director of the Paris Observatory, who died on Tuesday.

The Academy of Natural Sciences of Philadelphia has conferred the Hayden Memorial Geological Award for 1896 on Prof. Giovanni Capellini, of the University of Bologna.

A slight earthquake occurred on the 16th inst. in Northwest Italy. A small shock was felt at several places in Southern Piedmont and in Liguria, but no damages have been reported. The disturbance was observed by Prof. Guido Cora in Costigliole d'Asti, and he informs us that the shock took place at 7.18 a.m.; it was undulatory, in the direction from north to south, and lasted only a few seconds.

Mr. William Whitaker, F.R.S., who joined the Geological Survey of Great Britain in 1857, has just resigned his post on the staff. For many years he has acted as District Surveyor in superintending the survey of the southern counties of England. The loss of his experienced services will be much felt by his colleagues, to say nothing of the loss of an ever-cheery companion. We trust he may long live to labour in the cause of geology.

The Paris correspondent of the *Times* reports the occurrence of a serious explosion, on Saturday last, in a building where for two months M. Raoul Pictet, the distinguished chemist, has been manufacturing acetylene. One of the steel tubes, 3 feet long, used for storing the new gas, exploded. Such was the violence of the explosion that the building was blown up, and the windows of all the neighbouring houses were shattered. It has been ascertained from the fragments that the tube which burst, and which was practically full, was returned from Brussels on the 13th inst. along with seventy-four empty ones. The exact cause of the explosion is at present unknown.

We regret to see announcements of the deaths of Dr. David Garber, Professor of Mathematics and Astronomy in Muhlenburg College, Allentown, Pa.; Dr. Theodor Margo, Professor of Comparative Anatomy and Zoology in the University of Budapest; Dr. Rochard, formerly President of the Paris Academy of Medicine; Dr. W. H. Ross, formerly Professor of Anatomy in the Mobile Medical College, Alabama; Dr Callender, Professor of Neurology in the Vanderbilt University, Nashville.

The following gentlemen have been nominated by the Council of the London Mathematical Society for election as the Council and officers for the ensuing session:—President, Prof. Elliott, F.R.S.; Vice-Presidents, Major Macmahon, R.A., F.R.S., M. Jenkins, and Dr. Hobson, F.R.S.; Treasurer, Dr. J. Larmor, F.R.S.; Secretaries, R. Tucker and A. E. H. Love, F.R.S.; other members, Lieut.-Colonel Cunningham, R.E., H. T. Gerrans, Dr. Glaisher, F.R.S., Prof. Greenhill, F.R.S., Prof. Hill, F.R.S., Prof. Hudson, A. B. Kempe, F.R.S., F. S. Macaulay, and D. B. Mair. At the annual general meeting of the Society, which will be held on November 12, Major Macmahon will take as the subject of his valedictory address, "The Combinatory Analysis." On the same evening the De Morgan medal will be presented to S. Roberts, F.R.S., who will be the fifth recipient of the medal.

Conjointly with the Leigh Browne Trust, the Humanitarian League has arranged a series of five "Humane Science Lectures," to be given at St. Martin's Hall, Trafalgar Square, W.C. The programme is as follows: October 27, "The Need of a Rational and Humane Science," by E. Carpenter; November 17, "Natural Selection and Mutual Aid," by P. Kropotkin; December 8, "The Humane Study of Natural History," by J. Arthur Thomson; January 19, "The Treatment of Criminals," by Rev. Douglas Morrison; February 9, "Suggestion: its place in Medicine and Research," by Dr. Milne Bramwell. The general title, under which the lectures are grouped, is explained in the following extract from the prospectus. "The various departments of science are ever growing rapidly in extent, so rapidly that their correlation tends to fall behind, and in some directions to be overlooked; yet this correlation is not only an end, but a means of scientific progress. The objects, methods, and results of each department should tend to the advance of science as a whole, physical and mental, and only when thus directed will they conduce to permanent human welfare. An uncorrelated department of science tends to lose either life or balance. To illustrate this, and to show methods of research which do not violate the essential unity of nature, and the excellent result to be obtained by such methods, is one of the aims of the proposed course of lectures."

Fifty years ago last Friday, on October 16, 1846, the first surgical operation under the influence of ether was performed in the Massachusetts General Hospital, Boston, by Dr. John C. Warren, the anæsthetic being administered by Dr. W. T. G. Morton, who had already proved its anæsthetic properties in tooth extraction. In commemoration of the introduction of this blessed relief to suffering humanity, the current number of the *British Medical Journal* contains a very interesting account of the circumstances attending the discovery and use of ether as an anæsthetic, and of the subsequent introduction of chloroform into general use. The credit of having practically proved for the first time the possibility of abolishing sensation so entirely that a painful operation could be done without being felt, belong to Horace Wells, a young dentist of Hartford, Connecticut, who had a tooth extracted while under the influence of nitrous oxide gas on December 11, 1844. Morton followed with the use of ether in 1846, and in the next year Sir James Simpson communicated his discovery of chloroform to the Medico-Chirurgical Society of Edinburgh, in a paper entitled "Notice of a New Anæsthetic Agent as a Substitute for Sulphuric Ether," the first operation under its influence being performed on November 15, 1847. To Simpson also belongs the credit of having made anæsthesia triumph over the violent opposition with which it was assailed. In addition to a general history of anæsthetics, the *British Medical Journal* contains an account, by Dr. W. Squire, of the first operation under ether in Great Britain, and a retrospective article by Dr. Dudley W. Buxton.

Two interesting instances of birds apparently profiting by experience are related by Dr. R. Williams in the *Zoologist*. The proprietor of a certain wood, having found that the wood was a nesting stronghold of blackbirds and thrushes, made systematic raids on their nests in consequence of the damage done by the birds to his fruit. The result was that both the blackbirds and thrushes departed from their usual habit in the choice of nesting sites, and, instead of building in the thickets and small fir-trees with which the wood abounded, they built their nests upon the ground. The second case refers to the common sandpiper, which usually nests on patches of gravel thrown up by a river, and more or less covered with docks and other weeds. On one occasion when the sandpipers had built their nests and commenced to sit, the river near Dr. Williams' house overflowed its banks, and the nests were destroyed. On the subsidence of the water, the birds built again on their old sites, only to have their nests again swept away by another flood. In the next season the sandpipers neglected the eligible riparian building sites, and nested away from the river. The observations indicate that the birds remembered former calamities, and made use of their dearly-bought experience by choosing positions inaccessible to the highest flood. The birds continued to nest at some distance from the river for three seasons, after which they resumed their former nesting-places close to the water.

From a short article in the *Chemical News*, we learn that in the course of researches on monazite sand, M. P. Barrière appears to have come upon a new elementary body, to which he has given the name *Lucium*, and which he purposes using for the production of an incandescent gas light similar to that of Auer von Welsbach. Careful investigation has been made of the new and independent character of lucium, in order to prove that its use was not anticipated by the Welsbach patents. The examination showed that while the salts of cerium, lanthanum, and didymium form with sodium sulphate insoluble double salts, lucium does not. Thorium and zirconium form insoluble double salts with potassium sulphate; this is not the case with lucium. Yttrium, ytterbium, and erbium are not precipitable by sodium thiosulphate, whilst lucium chloride is precipitable. From glucinium lucium differs, as its salts are precipitable by oxalic acid. The lines in the spectrum of lucium are special, and only approximate slightly to those of erbium. Erbium oxide, on ignition, appears of a very pure rose-colour, and its nitrate is red. On the contrary, lucium oxide is white, slightly greyish, and its nitrate is white. The aqueous solutions of the erbium salts are red or rose-colour; those of lucium, even if containing 15 or 20 per cent. of the salt, are almost colourless. These and other reasons seem to show that lucium is a new distinct elementary body. Its atomic weight has been calculated as = 104.

The last number of *Modern Medicine and Bacteriological Review* contains a notice of some elaborate investigations which have been carried out by Drs. Chittenden and Mendel, of the Physiological Department of Yale University, on the influence of alcoholic drinks upon the chemical processes of digestion. The report in question was prepared by request, and presented to the Committee for the investigation of the liquor problem in New York. The investigations were made by means of artificial digestive experiments, in which the digestive fluids were allowed to act upon various food substances under definite and constant conditions. Absolute alcohol in four cases appeared to actually stimulate digestive action by a fraction of 1 per cent., but the amount of alcohol present did not exceed 1 or 2 per cent. Whenever alcohol was added in quantities over 2 per cent., digestive activity was markedly checked; in one instance, 3 per cent. of alcohol reduced the digestive activity by 17·6 per cent. Pure rye whisky containing 50 to 51 per cent. of alcohol yielded practically the same results; even an addition of 1 per cent. of this spirit was found, taking the average of the experiments, to reduce digestive activity by over 6 per cent. In three cases, however, an increase in digestive activity of from 3 to 5 per cent. was recorded when additions of whisky in the proportion of from 1 to 3 per cent. were made. Brandy, rum, and gin gave practically the same results. Messrs. Chittenden and Mendel consider that their experiments, as far as they go, justify them in concluding that "whisky can be considered to impede the solvent action of the gastric juice only when taken immoderately and in intoxicating quantities."

Several successful experiments of scientific kite-flying, for the purpose of exploring the upper air, have been made during the past summer at Mr. Rotch's observatory at Blue Hill, near Boston, and the results of some of these are noticed in *Science* of October 2. The kites used are of the tailless and the box patterns, provided with registering instruments specially made by M. Richard, of Paris. The altitudes reached are determined in three ways—by theodolites, by the angle and length of the kite-line, and by the barometric pressure recorded. The height of one mile was exceeded on six occasions; on July 20, at a short distance above the earth, the kite entered a cloud in which the humidity reached saturation, while after a further ascent of about 2500 feet, the air was found to be much dryer. On August 1, the recording instrument reached an altitude of 7333 feet above sea-level. The temperature at the maximum altitude was 20° less than at the observatory (640 feet above sea-level), while the relative humidity showed variations of 30 to 80 per cent. The results obtained from these investigations at Blue Hill are attracting much attention.

In the current number of the *Annales de Chimie et de Physique*, M. Moissan continues the account of his researches with the electric furnace. He gives the preparation and properties of titanium, molybdenum, uranium, and the borides of iron and of carbon, the preparation of manganese, and an historical account of the researches already made on the crystallised carbides of the alkaline earths. In the latter paper he lays claim to the discovery of crystallised carbide of calcium, while assigning to Mr. Wilson the credit of having introduced its manufacture in the United States. With regard to titanium, M. Moissan has found that with a current of 50 ampères and 50 volts, titanic acid is converted into crystallised oxide of titanium. With 350 ampères and 70 volts, the bronze-yellow nitride, Ti_2N_2, is obtained. When 1200 ampères and 70 volts are used, the temperature rises above the point of decomposition of this substance, and the carbide TiC, is formed, free from nitrogen; and if this is heated with an excess of titanic acid, titanium containing only 2 per cent. of carbon is obtained. These successive actions, says M. Moissan, give a decisive proof of the increase of temperature of the electric arc dependent on an increase of the current, and form the starting-point of another long series of experiments. The preparation of the crystallised compound of iron and boron containing over 15 per cent. of boron, and nearly corresponding to the formula FeB, effectually disposes of the assertion of some workers on iron that it is impossible to alloy these two elements.

The Australian Museum, Sydney, like many other colonial museums, suffers from lack of funds to acquire specimens by purchase. In the report of the Trustees of the Museum, lost opportunities due to this deficiency are lamented. To an enthusiastic curator nothing is more heartrending than to see objects urgently needed in the collection under his charge, and to be unable to acquire them; a woman coveting a pretty bonnet which she cannot buy, may be able to understand his feelings, but no one else could adequately sympathise with him. Owing to this want of funds, it has only been possible for a few isolated purchases to be made during the year 1895. The same difficulty applies to collecting, and consequently the Trustees have been unable to continue systematic exchanges with other institutions from which they have been accustomed to receive specimens. Notwithstanding these limitations, 11,499 specimens were acquired during the year. The more important acquisitions were:—A fine collection of mounted sheep, goats, and dogs from the museum at Florence, a large native drum from the Bismarck Archipelago, and one of Captain Cook's original MS. Journals, or Log of H.M.S. *Endeavour*, which was kept by him in triplicate. It is satisfactory to know that a sum of £6000 has been voted by Parliament for the further extension of the Museum buildings. The assistance came none too soon, for an accident to the plaster revealed the astounding fact that the woodwork of the entire roof over the central part of the main building had been destroyed by white ants. The destruction was so complete that it is surprising that the portion affected did not collapse. The building had to be temporarily supported in order to make it safe until funds became available for the erection of a new roof. In spite of these little tribulations, Mr. R. Etheridge, jun., and his assistants accomplished a large amount of work during the year covered by the report. Many of the collections have been thoroughly overhauled and rearranged, while the condition of all of them appears to have been improved.

Mr. T. Whitelegge, who has charge of the marine invertebrata in the museum, has conducted a number of experiments to test the value of formol as a preservative. The results have proved highly satisfactory, more especially in regard to delicate marine organisms; they show that a $2\frac{1}{2}$ per cent. solution is sufficient to preserve many delicate organisms, and that for most others a 5 per cent. solution is ample.

A LIST of books in which botanical book-hunters will be especially interested, is the "Bibliographie Botanique," just issued by Messrs. J. B. Baillière et Fils, Paris. The books and brochures in this catalogue are classified geographically.

A BRIEF account of the excursion to the Isle of Man, after the recent meeting of the British Association, was given in NATURE of the 8th inst., by Prof. W. A. Herdman. It may interest some of our readers to know that a complete descriptive report of this supplementary meeting of archæologists, geologists, zoologists, and botanists, occupying no less than fourteen columns, appears in the *Isle of Man Times* of October 3.

WE have received the Report of the Botanical Survey of India for the year 1895–96, by the Director, Dr. G. King. The Botanical Surveys of Northern India and of the Bombay Presidency have been steadily progressing; while that of Southern India has been temporarily interrupted by the death of its Director, Mr. M. A. Lawson. Work has also been done in Assam and in Burma.

IN connection with this Survey, Dr. D. D. Cunningham and Mr. D. Prain have published a very interesting "Note on Indian Wheat-rusts," containing a great deal of valuable information respecting the diseases known as "rust," which attack the wheat and barley crops in different parts of India, and which appear to belong to four different species of the genus of parasitic fungi *Puccinia*, and their connection with a fungus which attacks *Launea asplenifolia*, a very common weed among cultivated crops, belonging to the Compositæ.

MESSRS. WILLIAM WESLEY AND SON have prepared and issued a new "Natural History and Scientific Book Circular" (No. 126), containing titles and prices of nearly two thousand works on the Invertebrates. The catalogue comprises descriptions of handbooks and other general works, a classified list of works on the Invertebiates from Protozoa to Mollusca, arranged according to Claus' "Text-book of Zoology;" and a section on economic entomology. This intelligent arrangement of the titles makes the catalogue a useful index to zoological literature.

THE renowned *Zeitschrift für physikalische Chemie* has now a friendly rival in the *Journal of Physical Chemistry*, edited by Profs. Wilder D. Bancroft and Joseph E. Trevor, and published at Cornell University. The first number of the new journal contains articles on "Irreversible Cells," "Chemistry and its Laws," and "Ternary Mixtures," reviews of books, and critical digests of papers bearing upon different phases of physical chemistry. The journal thus follows much the same lines as its admirable German prototype, and we anticipate that it will play a similar important part in the development of the rich domain where the realms of physics and chemistry overlap. The publication will be issued every month except July, August, and September. The London agents are Messrs. Gay and Bird.

A FRESH light has been thrown on the constitution of the nitro-paraffins by the researches of Prof. Hantzsch, of Würzburg, which are recounted in a recent number of the *Berichte*. At one time it was thought that the presence of the nitro-group in the methane molecule imparted an acid function to one of the hydrogen atoms, and that in the formation of a salt this atom was replaced by the metal, which thus became directly combined with the carbon atom, the formula of sodium nitro-methane being written $CH_2Na.NO_2$. The researches of Nef and others have, however, shown that most probably the free nitro-paraffins have a different constitution from their salts, and that in the latter the metal is not directly combined with carbon, but with oxygen. Prof. Hantszch's discovery shows that this view is almost certainly correct. He has found that certain aromatic derivatives of the nitro-paraffins actually exist in two distinct forms, one of which, the normal compound, is an indifferent substance incapable of forming salts, and has the formula $R.CH_2\,NO_2$; whilst the other, the iso-compound, has the formula $R.HC\overset{O}{\diagup\!\diagdown}N.OH$, and acts in all respects as an acid. When, for example, a solution of the sodium salt of bromophenylnitromethane is acidified with hydrochloric acid, the iso-compound is precipitated as a crystalline mass, which melts at 90°. When this is preserved, however, either alone or in solution, it rapidly undergoes a molecular change, and after twelve hours melts at 60°, and has all the properties of the normal compound, which can itself be directly obtained from the solution of the sodium salt by decomposition with a weak acid, such as carbonic acid. The normal compound does not react with ferric chloride, is much less soluble than its isomeride, and in aqueous solution is a non-electrolyte; whereas the iso-compound is a stronger acid than acetic acid, and gives a characteristic colouration with ferric chloride, a further proof that it contains the hydroxyl-group. The normal compound is at once converted by alkalis into the iso-derivative, which then immediately dissolves, forming the corresponding salt.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus*, ♂) from India, presented by Dr. Allen M. Cleghorn; two Tigers (*Felis tigris*, ♀ ♀, juv.) from India, presented by H.H. the Gaekwar of Baroda; a Wild Cat (*Felis catus*), a Common Genet (*Genetta vulgaris*), two Avocets (*Recurvirostra avocetta*), two Eyed Lizards (*Lacerta ocellatus*), seven Green Lizards (*Lacerta viridis*), European, three Prairie Marmots (*Cynomys ludovicianus*), a Cat Bird (*Galeoscoptes carolinensis*) from North America, a Sulphury Tyrant (*Pitangus sulphuratus*) from South America, a Grey Coly Shrike (*Hypocolius ampelinus*) from Scinde, two Greater Black-backed Gulls (*Larus marinus*), a Herring Gull (*Larus argentatus*), a Black-headed Gull (*Larus ridibundus*), British, presented by the Lord Lilford; two Grey Francolins (*Francolinus ponticerianus*) from India, presented by Lieut.-Colonel D. K. Robertson; a Loggerhead Turtle (*Thalassochelys caouana*) from Spain, presented by Miss A. Steer; five Spotted Salamanders (*Salamandra maculosa*), European, presented by Miss Minks; a Yellow-cheeked Lemur (*Lemur xanthomystax*) from Madagascar, a Moorish Tortoise (*Testudo mauritanica*) from North Africa, deposited; two Nylghaies (*Boselaphus tragocamelus*, ♂ ♀) from India, received in exchange.

OUR ASTRONOMICAL COLUMN.

TELEGRAMS ABOUT COMETS.—At the meeting of the Telegramm-Commission at Bamberg on September 18 last, it was decided to make an alteration in the scheme of cypher that has been in use up to the present time. It has now been settled that the *date of observation* and the *brightness* of the object shall be included in a group of five figures, and allowed for in the "control" figures, which are always added as a check.

To prevent mistakes the following example is added—

"Comet Witt D.A. 09120 October 13000 Berlin, Urania. 02554, 07630, 35946, 35957, 04207."

This reads when deciphered—

"New Comet Witt 1896 D.A. 9 October, 13h. mean time Berlin, Urania. Apparent R.A. = 25° 54′. Apparent N.P.D. 76° 30′. Daily movement − 14′, − 3′. Magnitude 12m."

In cases where it is impossible to give the magnitudes, the three last figures will be written as three zeros.

This alteration will come into use on the first of next month (November) in all telegrams from the "Centralstelle" in Kiel.

Comets Perrine (1895 IV.) and Perrine-Lamp (1896).—A most interesting description of these two comets, obtained from eye observations and photographs, is given by Joseph and Jean Fric, in a communication presented on April 24 of this year to the Cisaře Františka-Josefa (5th year, No. 26). Up to the time of the perihelion passage of Comet Perrine, the observations made during this period were published in the *Bulletin* of the same Academy (No. 8), the last observation dating from December 9. The path of the comet at and since the time of its perihelion passage, is here indicated in the chart accompanying this communication. In the cliché taken on February 15 of this year, the tail of this comet appears in the form of a thin line, with a position angle of 120°, being turned towards the sun. This latter exceptional fact has been verified on two negatives taken on February 20 and 21, both of which were made under the best atmospheric conditions. The description of the original clichés that were taken on February 15, shows us that this comet presented a very dim line directed towards the sun, and of 1° in length. The nucleus was nearly of fifth magnitude, and resembled a star. This cliché is further interesting from the fact that it shows the first trace of the new comet Perrine-Lamp. On February 20 the tail presented a fan-like form, being somewhat more dense at the position angle 120°. Its breadth was 15′ at its centre, and its length 1½°. The position of the tail was abnormal, being turned towards the sun. By April 21 its length had increased to 2°. On March 15 only the nucleus was visible, and by the 20th a photograph showed only a feeble trace of it. The clichés which show the appearance of the Perrine-Lamp comet are also full of interest. A striking feature of these photographs is the bifurcation of the tail, exhibited on the cliché made on February 22 and March 3, and its spontaneous development on February 21 and 22. The direction of the tail, in its relation to the sun, was normal. The communication contains, besides the chart referred to above, reproductions of the several clichés mentioned in the pamphlet.

The Canals of Mars.—First Schiaparelli and then Lowell have both shown us that the Martian surface is a network of canals. The number of canals, as the latter observer informs us, is really far more numerous than has yet been recorded, but these are less in size, and only flash out clearly under the very best and exceptional conditions of seeing. As one would expect, the greater the number of canals, the greater becomes the difficulty in identifying them. In fact, unless one has first-class conditions for observation, and also considerable experience, it is rather rash to suggest the discovery of new canals. Mr. Brenner seems, however, to be certain of his powers of identification, and describes some of his observations in the *Bulletin de la Société Astronomique de France* (October). Without diagrams it is unsatisfactory to try to describe the positions of these suspected new canals, but a reference to Mr. Lowell's chart seems to indicate that these may be cases of not exact identification. Mr. Brenner makes it very difficult for readers of his notes, as he inserts woodcuts of the surface markings, numbered most carefully, these numbers having no reference at all to the text. For instance, referring to one of the drawings he says: "One sees the following canals: (1) Steropes, (2) Glaucus, (3) Phlegethon, (4) Cérannius, &c."

As these are the only numbers used in the text, it is natural to suppose them to refer to the illustrations; this, however, is far from the case, hence the delusion.

An interesting point is touched upon by Prof. V. Cerulli, concerning the conspicuousness of the canals Ulysses and Sitacus. These canals are not charted by Schiaparelli, but were discovered by Lowell two years ago Prof. Cerulli asks the question, How is it that they have been previously not seen, considering that the former is now as prominent as Sirenius and Araxes, both in the chart of Schiaparelli, and that the latter surpasses in distinctness the Euphrates and Phison? They are not simply canals that were observed in 1894 for the first time, but they are canals which till then had no existence. Mr. Lowell also remarked a peculiarity in this respect. Referring to the canals not on Schiaparelli's chart (Lowell, "Mars," p. 148) he says: "The most peculiar case, however, is the relative conspicuousness of the Ulysses."

THE HUXLEY LECTURE.—RECENT ADVANCES IN SCIENCE, AND THEIR BEARING ON MEDICINE AND SURGERY.[1]

II.

Now let me turn to another theme suggested by what has happened in science and in the profession since the days of Huxley's studentship, and that is the complexity of the bearings of any one discovery, of any one advance, as well on science itself as on the applications of science.

In the garment of science, with which man is wrapping himself round, or rather is being wrapped round, the several threads are woven into an intricate web. As the loom which is weaving that ever-spreading garment takes in new warp and new woof, such threads only of each are taken in as can be fitly joined to those which have come in before, each thread as it is twisted in becomes a hold for other threads to be caught up later on. No single observation, no single experiment stands alone by itself, nor can its worth be rightly judged by itself alone. The mistaken philanthropists who have put restrictions, and would put more on physiological investigations, betray that ignorance of the ways of science, which seems to be a necessary condition of their attitude, when they ask us to state in a sentence the direct application to the good of man of each experiment on a living animal. In the doors of science, each the opening as often of a path as of a chamber, it is not, as such folk seem to think, that each bobbin pulls only one latch. Every experiment, every observation has, besides its immediate result, effects which, in proportion to its value, spread away on all sides into even distant parts of knowledge. The good of the experiment by itself is soon merged in the general good of scientific inquiry. The science of physiology, and by implication the art of medicine, is built up in part on experiments on living animals; in part only, but that part is so woven into all the rest that any attempt to draw it out would lead to a collapse of the whole.

It is because each experiment or observation is thus a thread caught up in a close-set web, that its value depends not alone on the mere result of the experiment or observation itself, but also, and even more so, on the time at which, and on the circumstances and relations under which it is made. This truth the real worker in science has borne in upon him again and again; it is this which leads him to that humility which has ever been the outward token of the fruitful labourer. He feels that it is not so much himself working for science as science working through him.

Let me attempt to illustrate this by dwelling on some two or three single observations in physiology, made almost at the time, or very soon after the time at which Huxley was a student. It will, I think, be seen that each of them has reached a long way in its bearing on the science of physiology and on the art of medicine, that the full effect of each has been dependent both on what went before and on what has happened since, and though they were all made, so to speak, long ago, some of their fruits were brought in as it were yesterday, and their full fruition is perhaps not yet accomplished.

I will first invite your attention to a single experiment, for, though repeated on various animals, we may call it a single experiment, which in the fall of the year 1845 Ernest Heinrich Weber, then Professor of Anatomy at Leipzig, and his brother Eduard Friedrich, reported to an assembly of Italian scientific men in Naples, and of which they subsequently published an account in Müller's *Archiv* in 1846. Making use of the recently introduced rotating electro-magnetic apparatus (the physical discovery begetting the physiological one), they found that powerful stimulation of the vagus nerves had the unexpected result of stopping the heart from beating.

This single experiment, which I may quote by the way as a typical experiment on a living animal—for it is impossible to imagine how the discovery of this action of the vagus on the heart could have been made otherwise than by an experiment on a living animal—this single experiment has made itself felt far and wide throughout almost the whole of physiology.

In the first place, it has made us understand in a way impossible before the experiment, how through the intervention of the nervous system, the work of the heart is tempered to meet the strain of varying circumstances. As I said a little while back, only a few years before even eminent observers were

[1] Delivered at Charing Cross Medical School, on October 5, by Prof. Michael Foster, Sec. R.S. (Continued from p. 583.)

groping about in a dim light, hotly discussing whether the brain and spinal cord could affect the beat of the heart. To all these discussions Weber's experiment came as a great light in a dark place.

There is no need for me to insist how this knowledge that impulses descending the vagus slow or restrain the heart beat, and the knowledge genetically dependent on this, that impulses reaching the heart along the cardiac sympathetic nerves from the thoracic spinal cord, stir up the heart to more vigorous or frequent beats, have since served as a guide for the physician in the intricate problems of cardiac disease, and that with increasing security as our knowledge of the details of the actions has increased. The knowledge may not always have been wisely used. On this point perhaps I may be allowed to repeat the caution which I may have given elsewhere, concerning the dangers of taking a new physiological fact direct and straight, raw and bleeding as it were, from the laboratory to the bedside. The wise physiologist takes care, even in physiology itself, not to use a new fact as an explanation of old problems without a due testing and a direct verification of its applicability. How much more is it needful that the doctor who sails not on the calm seas of the phenomena of health, but amid the troubled tempests which we call disease, should not hastily and heedlessly rush to make practical use of a new fact, tempting as the use may be, until he also has tested its applicability by that clinical study which is his only sure guide. But this is by the way.

In the second place, as a mere method, Weber's discovery has in physiological experimentation borne most important fruit. Before Weber's experiment many an investigation, not only on the vascular system itself, but in many other branches of physiology, came to a standstill or went astray because the experimenter had not the means on the one hand to stop or slacken, or on the other to quicken and stir up the heart, without interfering largely with the object of his research. Thanks to Weber's experiment and what has come out of it, that can now be done with ease, and thus solutions have been obtained of problems which otherwise seemed insoluble.

In the third place, the experiment has had a profound and widespread influence by serving to introduce a new idea, that idea which we now denote by the word inhibition. Before the experiment, though men's minds were gradually getting clearer concerning the nature of a nervous impulse, all known instances of the action of a nervous impulse had for the result an expenditure of energy; and it was a still open, though hotly debated question whether in such actions as when a muscle was thrown into contraction by a nervous impulse this feature of expenditure was not impressed on the muscle by the very nature of the impulse itself. That question the experiment answered in the negative once and for all. Whatever the exact nature of a nervous impulse, it was evidently of such a kind that it might on occasion check expenditure and bank up energy in an increased potential store. Observation soon showed that the heart and vagus was no solitary example. It was recognised that the due regulation of many of, if not all, the so-called nervous centres was secured not merely by the intrinsic forces of passive rest making themselves felt in the absence of stimulation, but also, and even more so, by the alternating play of antagonistic influences. Throughout all the sciences the resolving a stability seemingly due to intrinsic causes into an equilibrium arising out of the balance of opposing forces, has again and again marked a step forward; and it is perhaps not too much to say that a like analysis, prompted by the story of the vagus and the heart, has profoundly modified all our conceptions of the way in which nervous impulses, sweeping along the intricate yet ordered network of paths in the brain and spinal cord, determine the conduct of life. The idea has of course been abused as well as used, as what idea has not? Such a word as inhibition could not but fail to have a blessed sound in the ears of the ignorant; the idea has been ignorantly and wrongly applied; but this is of little moment in view of the help which it has given to wise and well-directed inquiry.

And the idea has spread with fruitful results beyond the limits of nervous impulses; it has been carried deep down into the very innermost molecular processes of life. The closer we penetrate into the physical-chemical events through which living matter grows, lives and dies, the clearer does it seem that life itself is a shifting outcome of two opposing sets of changes—one synthetic constructive, the other destructive, analytic, and that the key to this and that riddle of vital action lies within the grasp of him who can clearly lay hold of the mutual relations of these conflicting changes. The story of the vagus and the heart is a tale, not of the heart alone, not of the nervous system alone, but of all living matter. The light which first shone in the experiment of the brothers Weber may in a sense be said to have gone out into all the lands of physiology.

Let me now turn your attention to an experiment made a few years later. This is also an experiment made on a living animal, and whatever good may have come out of that to which it has given rise must be reckoned as the fruit of an experiment.

In 1851, Claude Bernard made known that division of the cervical sympathetic led to a widening of the blood-vessels and a warming of the ear and other parts of the head and neck. This was the beginning of what may rightly be called the great vaso-motor knowledge. It may be true that more than a hundred years before, in 1727, Du Petit had observed much the same thing, but nothing came out of it; the germinal time had not yet arrived. It may be true that other observers since Du Petit had divided the cervical sympathetic, and noted the effects; but these had their attention directed chiefly to changes in the pupil. It may be true that Brown-Séquard and Waller, a few months before Bernard himself was able to do so, supplied the complement to the original experiment by showing that stimulation of the peripheral part of the divided sympathetic constricted the blood-vessels and reduced the temperature. All this may be true, but there remains the fact that with Bernard's experiment the new light began; that experiment marks the beginning of our vaso-motor knowledge.

I have already spoken of the prolonged discussions, which just before the date of Huxley's studentship were taking place, touching the question whether or no the blood-vessels were muscular and contractile. That question had, meanwhile, been definitely settled by Henle's demonstration, in 1840, that the tissue in the middle coats of arteries really consisted in part of muscular tissue, of the kind known henceforwards as plain muscular tissue. But for some years no use was made of this discovery in the direction of explaining the intervention of the nervous system in the government of the circulation. That began with Bernard's experiment.

It would, I venture to think, be sheer waste of your time and mine, if I were to attempt to labour the theme of the large share in our total physiological knowledge which is now taken up by the vaso-motor system and all that belongs to it, and of the extent to which the physiology of that system has woven itself into pathological doctrines, and helped medical practice. I would simply ask the lecturer on physiology in what stress he would find himself if he were forbidden in his teaching to say a word which would imply that the calibre of the blood-vessels was influenced by the contraction of their walls through nervous influence; or ask the student how often, in an examination of to-day, he would have to sit seeking inspiration by biting his pen, or staring at the roof, if he too, in his answers, could never refer to vaso-motor actions. Whatever part of physiology we touch, be it the work done by a muscle, be it the various kinds of secretive labour, be it that maintenance of bodily temperature which is a condition of bodily activity, be it the keeping of the brain's well-being in the midst of the hydrostatic vicissitudes to which daily life subjects it—in all these, as in many others, we find vaso-motor factors intervening; and, to say nothing of the share taken by these in the great general pathological conditions of inflammation and fever, they also have to be taken account of by the doctor in studying the disordered physiological processes which constitute disease, whatever be the tissue affected by the morbid conditions. Take away from the physiological and pathological doctrines of to-day all that is meant by the word vaso-motor, and those doctrines would be left for the most part a muddled unintelligible mass. To so great an extent as that which Bernard's experiment began entered into our modern views.

It was Bernard's good fortune, but deserved good fortune, to announce, almost at the same time, two fundamental discoveries. For I venture to claim for his discovery of the formation of glycogen in the liver, briefly indicated in 1850, more fully expounded in 1851, an importance only second, if second, to that of the experiment with which we have just been dealing.

To judge of its importance we must look at it from more than one point of view.

At the time when Huxley was sitting at the feet of Wharton Jones, the teaching of the Schools was largely governed by the view that the animal organism, in contradistinction to the vegetable organism, was essentially destructive in its chemical actions,

possessing no power in itself of synthetic construction. It is true that the possible synthesis of organic compounds special to the animal body had long before, in 1828, been shown by Wöhler's artificial formation of urea. It is true also that Huber, in the case of bees, and Liebig, in the case of cows, had already shown that wax and fat must be in part manufactured out of something that was not fat. The conclusions, however, of these observers were at best somewhat distant inferences from statistical data; and, in any case, had not as yet made much way in the direction of general acceptance. But Bernard's experiment was in the form of an ocular demonstration. The glycogen which had been formed in the liver could be extracted, could be seen, handled, and, if need be, tasted, a result adequate to convince even a physiological Thomas. We may claim for Bernard's glycogen discovery that as the first realistic proof of the synthetic powers of the animal organism it did much to establish a truth, which succeeding observations have only served to confirm and extend, namely, that the animal, no less than the vegetable organism, possesses synthetic powers, and that the want of prominence of these in the ordinary work of the animal body is to be attributed to economic reasons, and not to absence, or even scantiness of power.

But there is another aspect from which the discovery must be viewed.

At the time of which we are speaking, physiologists were still, as they had been of old, largely under the influence of a somewhat mechanical conception of the body as a collection of organs, each of which had its special use or function, the unity of the body being maintained by the mutual adaptation of the constituent organs. This was further developed into the view that when a use of an organ had been satisfactorily made out, when a function had been made clear, all that remained to be done, in the way of research, was simply to inquire how far and in what ways the performance of that function was influenced by changes in the rest of the body, or by external circumstances. It was acknowledged, for instance, on all hands that the function of the liver was to secrete bile, and physiologists in general were content to look forward for future discoveries which should throw light on the exact nature of the mechanism of the secretion, and on why the liver secreted now more, now less bile, and to these alone without expecting anything else.

Bernard's discovery that the liver not only secreted bile, but manufactured glycogen, fell on physiologists like a bolt from the blue. The knowledge that the same hepatic cell was engaged both in secreting bile and manufacturing glycogen, and that the sugar or other products of digestion were carried from the intestine, not straight to the tissues which they were destined, in any case, ultimately to nourish, but to the liver, there to undergo transformation and await some future fate, marked the beginning of a new way of looking at the problems of nutrition. It was recognised that these became less simple, more complex than they had formerly seemed; but the very complexity gave hope of possible solutions. It was seen that as the blood swept in the blood stream through the several tissues, it might undergo profound changes without any visible outward token, such as that of the appearance of secretion in the duct of a gland, or of the contraction of a muscle, might undergo changes which could only be demonstrated by differences in the composition or properties of the blood as it came to or left this or that tissue. The technical difficulties of the analysis of blood prevented any immediate marked steps in the way of advance, and attempts to establish, in respect to any particular tissue, the changes which the blood underwent in it, by inference from the results of experimental interference, met with difficulties of another but no less serious kind. Hence the world had to wait some little time before the new idea which Bernard's discovery had started bore important or striking fruit. Yet it was not very long before it was seen that the hepatic cell had heavy duties touching the metabolic changes of proteid, as well as a carbohydrate material; that it, and not the kidney alone, had to do with urea as well as sugar, and the difficulties, which physiologists in the early half of this century must have keenly felt, how to reconcile the bald task of secreting bile, which alone technical physiology allotted to the liver, with the overweening importance which not only popular experience, but more exact clinical study, could not but attach to that organ, began to steal away. A little later on, exact experimental inquiry converted into certainty the suspicions which clinical study had raised, that the blood in streaming through the thyroid gland underwent changes of supreme importance to the nutrition of the tissues of the body at large. Still, a little later, the Bernardian idea, if I may so venture to call it, doubling, so to speak, on itself, led to the discovery that the mysteries of the fate of sugar in the body were not lodged in the liver alone, but might be traced to the pancreas. It was seen that as the blood streaming through the liver worked on sugar, besides secreting bile, so the pancreas, besides secreting its marvellous omnipotent juice, also influenced, though in a different way, the career of sugar in the body, that the disease we call diabetes was or might be in some way connected with the pancreas no less than with the liver. I need not go on to speak of recent researches on the supra-renal capsules or of other organs. It is enough to note that one of the most promising lines of inquiry at the present day is that relating to the changes of which I am speaking, sometimes known under the name of "internal secretion." Every year, nay, almost every month, brings up some new light as to the details of the great chemical fight which the blood is carrying on in all the tissues of the body—it may be perhaps to-morrow that we shall learn of some work of a kind wholly unexpected which is carried out by that great Malpighian layer of the skin which wraps round our whole frame. In any case, the line of inquiry is one of the most fruitful of those of the present day. I may add too, I think, that it is one which has been of the greatest direct use to mankind, and promises still more. It is true that Bernard's discovery of glycogen, and perhaps especially the diabetic puncture, raised hopes which have not been fulfilled. Not to-day, any more than forty years ago, it is in our power wholly to remove the disease which we call diabetes. But short of complete mastery, how great is our power now compared with then. And when we remember that the pancreatic relations of sugar are far from being worked out, and that such knowledge as physiologists already possess has not yet made much way in clinical study, we may look forward to marked progress possibly in no very distant time.

Further, if there be any truth in what I have insisted upon—that the value of a discovery is to be measured not only by its immediate application, theoretical and practical, but also by the worth of the idea which it embodies and to which it gives life; and if it be true, as I have suggested, that by the genesis of ideas the discovery of glycogen is mother of all our knowledge of internal secretion, in its widest sense, of the work of the thyroid and other like bodies, then the good to suffering mankind which may be laid to the door of Bernard's initial experiment is great indeed.

The next result to which I will call your attention is again an experiment, and once more an experiment on a living animal. In 1850, Augustus Waller described, in the *Philosophical Transactions*, the histological changes which division of the hypoglossal and glosso-pharyngeal nerves in the frog produced in the fibres of the distal portions of the nerves, and shortly afterwards developed this initial result into the more general view of the dependence of the nutrition of a nerve-fibre on its continuity with a cell in the central nervous system, or in the case of afferent fibres, in the ganglion of the posterior root.

This discovery was at the time, and has since continued to be of value as a contribution to physiological ideas; it had its share in promoting the progress which, though slight, is still a progress, of our understanding the obscure influences which the part of a cell enclosing the mysterious nucleus exercises over all the rest of the cell. And perhaps even to-day the theoretical value of that degeneration of nerve-fibres, the knowledge of which we owe to Waller, is not adequately appreciated, and the lead which it gives not followed out as it might be. In spite of all we know, we are too much apt to fall back on the conception that, when no nervous impulse is travelling along a nerve-fibre, the nerve-fibre is in a state of motionless quiescence, and that a nervous impulse, when it does come, sweeps over the fibre as a wave sweeps over a placid lake. But the Wallerian degeneration gives such a view the lie direct. When we reflect that the finely-balanced molecular condition, which itself is nothing more than the falsely seeming quiescence of an equilibrium of opposing motions, in the ultimate fibrils of the nerve-twigs, in the ultimate phalanx of the finger, by which we touch and get to know the world without us, is dependent on what is going on around the nucleus of a cell, or the nuclei of some cells in the ganglion or ganglia of certain upper spinal nerves, so that if the continuity of the axis cylinder process be anywhere broken, the figure of the molecular dance changes at once, and riot takes the place of order. When we reflect on

this, it is clear, I say, that between the molecules of the ultimate fibrils branching in the Malpighian layer of the ball of the finger, and the molecules within the immediate grasp of the nucleus of the cell from which those fibrils start, there must be ever-passing thrills—thrills, it is true, of so gentle a kind, that no physical instrument we as yet possess can give us warning of them, so gentle, that compared with them, the wave, which carries what we call a nervous impulse, must appear a roaring avalanche, but still thrills the token of continued movement. And of such gentle impalpable unnoticed thrills, we must in the future take full account, if we are ever to sound the real depths of nervous actions.

It is not, however, as a contribution to theoretical conceptions, but rather as a method, that the results of Waller have so far had their chief effect on the progress of physiology and medicine. And I have chosen it as a thing to dwell on, because it seems to me a striking instance of the value of a method merely judged as a method, and, further, because the value of its use illustrates my theme that the success of any one scientific effort is contingent on the converging aid of other efforts. For some time, it is true—for years, in fact—the Wallerian method was employed solely or chiefly in what, without reproach, may be called the smaller problems of physiology; it settled many topographical questions, it cleared our views as to the distribution of afferent and efferent fibres; it seemed to add or replace a few stones here and there in the growing building, but it did not greatly change the whole edifice. After a while, however, it met with two helpmates—the one sooner, the other later—and, by means of the three together, we have gained, and are still gaining such additions to our knowledge of the ways in which the central nervous system works out the acts which make up our real life, as to constitute perhaps the most striking progress in the physiology of our time. A wholly new chapter of nervous physiology has, through them, been opened up.

The one colleague is to be found in the experiments of Fritz and Hitzig; and of Ferrier, again, experiments on living animals—experiments which, by demonstrating the existence of definite paths for the play of nervous impulses within the central nervous system, opened up paths for the play of new ideas concerning the working of that system. I say "demonstrating the existence of definite paths," for this—and not the topographical recognition of so many centres of hypothetical nature—is the solid outcome of experiments on local stimulation of the cerebral cortex. Views come and go as to what is happening when the current is flitting to and fro between two electrodes placed on a particular spot of the Rolandic area; the solid ground on which each view strives to establish itself is, that the particular spot is joined by definite nervous paths to particular peripheral parts. I say "demonstrating the existence of particular paths," but what would have been the demonstrative value of the experiments of stimulation, or of removal, by themselves, without the anatomical support furnished by the Wallerian method? And I may justly include within the Wallerian method, not the mere tracking out the degenerated fibre by the simple means at Waller's own disposal, but such finer, surer search as is afforded by the later help given by the newer development of the staining technique.

They who have the widest experience of experiments on living animals are the first to own that in a region of delicate complexity like that of the central nervous system, the interpretation of the results of any experimental interference may be, and generally is, in the absence of aid from other sources, a matter of extremest difficulty, one in which the observer, trusting to the experiment alone, may easily be led astray. I need not labour the question what would have been the value of the mere effects of stimulating or even of removal of parts of the cerebral cortex, and whither would they have led us, had the experimental results not been supported and their interpretation guided by the teachings of the Wallerian method. It is not too much to say that the experiments of Ferrier and his peers, brilliant as they were, might have remained barren, useful only as isolated bits of knowledge, or might even have led us astray, had they not been complemented by anatomical facts. They have not remained barren, and they have not led us astray. The Wallerian method picked out from the tangle of nerve fibres making up the white matter of the brain and spinal cord, the pyramidal tract running from the Rolandic area, to the origins of all the motor roots, even of the lowest, and so joining hands with the experiment, made it clear that whatever might be the exact nature of the events taking place in a particular spot of the cortex of that area, that spot was, by the definite paths of particular nerve fibres, put in connection with definite skeletal muscles. The pyramidal tract was further shown to be merely one—an important one, it is true—but still merely one of a large class. So it is that the experimental results and the Wallerian results, not merely in that Rolandic area where the results of experiment take on the grosser form of readily appreciated interference with movements, but in other regions where other finer, more occult manifestations of nervous and psychical actions have to be dealt with are, it may be slowly, but yet surely, resolving that which seemed to be a hopeless tangle of interweaving and interlacing nerve fibres and cells, into an orderly arrangement of which the key is seen to be that each nerve filament is a path of impulses coming from some spot—it may be from near, it may be from afar—where events are taking place, and carrying the issue of those events to some other spot, there to give rise to events having some other issue.

But a third factor was wanting to forward our insight into this orderly arrangement, and especially by again affording an anatomical basis to open the way towards explaining what was the order of events in the spots or centres, as we call them, in which the filaments began or ended, and what was the mechanism of the change of events. This, I venture to think, we may find in the special histological method which, however much its usefulness, has been enhanced by its subsequent development in the hands of Cayal, Kölliker, and others, as well as by the coincident methyl-blue method we owe to Golgi. The final word has not yet been said as to the exact meaning and value of the black silver pictures which that method places before us; but this, at least, may be asserted that by means of them the progress of our knowledge of the histological constitution of the central nervous system has within the last few years made strides of a most remarkable kind. It may be that those pictures are in some of their features misleading, it may be that the terminal arborisation, and their lack of continuity with the material of the structures which they grasp, does not afford an adequate explanation of the change in the nature of the nervous impulses which takes place at the relays of which the arborisations seem the token; it may be, indeed it is probable, that we have yet much to learn on these points. But notwithstanding this, it must still be said that, by the help of this method, our knowledge of how the fibres run, where they begin and where they end within the brain and spinal cord, has advanced, and is advancing in a manner which, to one who looks back to the days when Huxley was studying within these walls, seems little short of marvellous.

Let me once more repeat, the value of this silver method is not an intrinsic one, it has its worth because it fits in with other methods, it is available on account of what is known apart from it. I imagine that if in 1842 Huxley, at Wharton Jones' suggestion, had invented the silver method, it would have remained unknown and unused. The time for it had not then come. The full fruition which it has borne, and is bearing in our day has come to it, because it works hand in hand with the two other methods, of which I have spoken—the Wallerian and the experimental method.

It is these three working together which have brought forth what I may venture to call the wonders which we have seen in our days, and I cannot but think that what we have seen is but an earnest of that which is to come. In no branch of physiology is the outlook more promising, even in the immediate future, than in that of the central nervous system. But surely I do it wrong to call it merely a branch of physiology. It is true that if we judge it by even the advanced knowledge of to-day, it takes up but a small part of the whole teaching of the science; but when we come to know about it that which we are to know, all the rest of physiology will shrink into a mere appendage of it, and the teacher of the future will hurry over all that to which to-day we devote so much of the year's course, in order that he may enter into the real and dominant part.

There is no need for me to expound in detail how the knowledge gained by the three methods, of which I have been speaking, in laying bare the secrets of nervous diseases, and opening up the way for successful treatment accurate and trustworthy prognosis, has helped onward the art of medicine. Even the younger among us must be impressed when he compares what we know to-day of the diseases of the nervous system with what we know, I will not say fifty, but even twenty, nay even ten, years ago. Do not for a moment suppose that I am attempting to maintain that the great clinical progress which

has taken place, has resulted from the direct, immediate application to the bedside of laboratory work, or that I wish to use this to exalt the physiological horn. I would desire to take a higher and broader standpoint, namely this, that the close relations and mutual interdependence of laboratory physiology and that bedside physiology, which we sometimes call pathology, and the necessity of both for the medical art, are nowhere more clearly shown than by the history of our recent advance in a knowledge of the nervous system as a whole. In this, when we strive to follow out the genesis of the new truths, it is almost impossible to trace out that which has come from the laboratory and that from the hospital ward, so closely have the two worked together; an idea started at the bedside has again and again been extended, shaped or corrected by experimental results, and been brought back in increased fruitfulness to the bedside. On the other hand, a new observation, which, had it been confined to the laboratory, would have remained barren and without result, has no less often proved in the hands of the physician the key to clinical problems, the unlocking of which has in turn opened up new physiological ideas.

And, though the scope of these Huxley lectures is to deal with the relations of the sciences to the medical art, I shall, I trust, be pardoned if I turn aside to point out that this swelling knowledge of how nerve-cell and nerve-fibre play their parts in bringing about the complex work done by man's nervous system, is not narrowed to the relief of those sufferings which come to humanity in the sick room. Mankind suffers, much more deeply, much more widely, through misdirected activities of the nervous system, the meddling with which lies outside the immediate calling of the doctor. Yet every doctor, I may say every thoughtful man, cannot but recognise that the distinction between a so-called physical and a so-called moral cause is often a shadowy and indistinct one, and that certainly so-called moral results are often the outcome, more or less direct, of so-called physical events. I venture to say that he who realises how strong a grip the physiologist and the physician, working hand in hand, are laying on the secret workings of the nervous system, who realises how step by step the two are seeing their way to understand the chain of events issuing in that sheaf of nervous impulses which is the instrument of what we call a voluntary act, must have hopes that that knowledge will ere long give man power over the issue of those impulses, to an extent of which we have at present no idea. Not the mere mending of a broken brain, but the education, development and guidance of cerebral powers, by the light of a knowledge of cerebral processes, is the office in the—we hope—not far future of the physiology of the times to come.

I might bring before you other illustrations of the theme which I have in hand. I could, I think, show you that the very greatest of all recent advances in our art, that based on our knowledge of the ways and works of minute organisms, has come about because several independent gains of science met, in the fulness of time, and linked themselves together. But my time is spent.

I should be very loth, however, and you, I am sure, would not wish that I should end this first Huxley lecture, without some word as to what the great man, whose name the lectures bear, had to do with the progress, on some points of which I have touched. He had an influence, I think a very great one, upon that progress, though his influence, as is natural, bore most on the progress in this country.

The condition and prospects of physiology in great Britain at the present moment are, I venture to think, save and except the needless bonds which the legislature has placed upon it, better and brighter than they ever have been before. At one time, perhaps, it might have been said that physiology was for the most part being made in Germany; for, in spite of the fact that some of the greatest and most pregnant ideas in physiology have sprung from the English brain, it must be confessed that in the more ordinary researches the output in England has at times not been commensurate with her activities of other kinds. But that cannot be said now. The English physiological work of to-day is, both in quantity and quality, at least equal to that of other nations, having respect to English resources and opportunities. Part of this is probably due to that activity which is the natural response to the stimulus of obstacles; the whip of the antivivisectionists has defeated its own end. But it is also in part due to the influence of Huxley.

That influence was two-fold, direct and indirect. I need not remind you that not only when he sat on the benches of Charing Cross Hospital, but all his life-long afterwards, Huxley was at heart a physiologist. Physiology, the beauty of which Wharton Jones made known to him, was his first love. That Morphology, which circumstances led him to espouse, was but a second love; and though his affection for it grew with long-continued daily communion, and he proved a faithful husband, devoting himself with steadfast energy to her to whom he had been joined, his heart went back again, and especially in the early days, to the love which was not to be his. What he did for morphology may perhaps give us a measure of what he might have done for physiology, had his early hopes been realised. As it was, he could show his leanings chiefly by helping those who were following the career denied to himself. Unable to put his own hand to the plough, he was ever ready to help others, whom fate had brought to that plough, especially us younger ones, to keep the furrow straight. And if I venture to say that the little which he who is now speaking to you has been able to do, is chiefly the result of Huxley's influence and help, it is because that only illustrates what he was doing at many times and in many ways.

His indirect influence was perhaps greater even than his direct.

The man of science, conscious of his own strength, or rather of the strength of that of which he is the instrument, is too often apt to underrate the weight and importance of public opinion, of that which the world at large thinks of his work and ways. Huxley, who had in him the making of a sagacious statesman, never fell into this mistake. Though he felt as keenly as any one the worthlessness of popular judgment upon the value of any one scientific achievement, or as to the right or wrong of any one scientific utterance, he recognised the importance of securing towards science and scientific efforts in general a right attitude of that popular opinion which is, after all, the ultimate appeal in all mundane affairs.

And much of his activity was directed to this end. The time which seemed to some wasted, he looked upon as well spent, when it was used for the purpose of making the people at large understand the worth and reach of science. No part of science did he more constantly and fervently preach to the common folk, than that part which we call physiology. His little work on physiology was written with this view, among others, that by helping to spread a sound knowledge of what physiology was, among the young of all classes, he was preparing the way for a just appreciation among the public of what were the aims of physiology, and how necessary was the due encouragement of it.

And if, as I believe to be the case, physiology stands far higher in public opinion, and if its just ambitions are more clearly appreciated than they were fifty years ago, that is in large measure due to Huxley's words and acts. I have not forgotten that he was one of a Commission whose labours issued in the forging of those chains to which I have referred; but knowing something of Commissions, and bearing in mind what were the views of men of high influence and position at that time, I tremble to think of what might have been the fate of physiology if a wise hand had not made the best of adverse things.

One aspect of Huxley's relations to science deserves, perhaps, special comment. On nothing did he insist, perhaps, more strongly than on the conception that great as are the material benefits which accrue from science, greater still is the intellectual and moral good which it brings to man; and part of his zeal for physiology was based on the conviction that great as is the help which, as the basis of the knowledge of disease, and its applications to the healing art, it offers to suffering humanity in its pains and ills, still greater is the promise which it gives of clearing up the dark problems of human nature, and laying down rules for human conduct. No token, in these present days, is more striking or more mournful than that note of pessimism which is sounded by so many men of letters, in our own land, no less than in others, who, knowing nothing of, take no heed of the ways and aims of science. Cast adrift from old moorings, such men toss about in darkness on the waves of despair. There was no such note from Huxley. He had marked the limits of human knowledge, and had been led to doubt things about which other men are sure, but he never doubted in the worth and growing power of science, and, with a justified optimism, looked forward with confident hope to its being man's help and guide in the days to come.

ZOOLOGY AT THE BRITISH ASSOCIATION.

SECTION D met on the afternoon of Thursday, September 17, in the Zoology theatre, University College, the President's address having been given in the Arts theatre in the morning. The principal feature of the Section was the large number of discussions, these occupying the mornings throughout the meeting, and two of them being in conjunction with the sections of Physiology and Botany (I and K).

Thursday, September 17.—The first paper was by Mr. R T. Günther, on Roman oyster culture. The author's facts were drawn both from classical writings and, also, from pictorial representations on ancient vases. Some of the latter gave fairly intelligible pictures of the processes used, and showed what means were adopted for attaching and preserving the young oysters. He believed that there was good evidence to show that ropes and other similar substances were used for the former purpose.

Mr. Walter Garstang read a preliminary communication on the utility of specific characters in the Brachyurous Decapods, referring, however, particularly to the crabs. The object of the inquiry was to ascertain the essential meaning of the denticulation of the edges of the frontal area of the carapace. The author first drew attention to the fact that in some crabs the respiratory current was from before backwards—the reverse of that believed to have applied in all cases by Milne Edwards. This led to the inference that the function of the serration was to filter off solid matter from the water entering the branchial chamber from before. This conclusion was supported by the fact that the denticulations were characteristic essentially of the burrowing crabs, in which, as being buried in sand, it was important that some filtration of the respiratory current should be provided for, in order to prevent the otherwise inevitable blocking up of the respiratory chamber by foreign matter. When, owing to the habits of a crab, the serrations should *à priori* be absent, they were, in fact, not found. The conclusion was that the denticulations on the frontal area of the carapace were functionally correlated with the flow of the respiratory current from before backwards, thus confirming the theory of natural selection by proving the utility of specific characters which would otherwise have been concluded as useless. In the discussion which followed, Prof. W. F. R. Weldon remarked how necessary it was to exercise caution before concluding that any specific characters were useless. Dr. C. H. Hurst drew attention to the anterior position of the renal aperture in Crustacea, which he thought implied a forward, and not a backward, flow of the respiratory current. He suggested that this might also be a diagnostic character in determining the direction of the flow, as it would doubtless be essential that the products of the nephridia should be carried away from the gills. The Rev. T. R. R. Stebbing stated that in many Crustacea the position of the renal aperture could not possibly be correlated with the flow of the respiratory current, and that, therefore, its forward position had no significance in this connection.

The following reports of Committees were then presented: (1) "The Zoology of the Sandwich Islands," by Prof. A. Newton. Three papers had been published as the result of the work of the Committee's collector, on the Orthoptera, Slugs, and Earthworms. Prof. Newton emphasised the importance of proceeding with the work as rapidly as possible, as the fauna in some parts was being partially destroyed by animals introduced into the islands. (2) "The Occupation of a Table at the Marine Biological Laboratory, Plymouth." The report dealt with the work of Mr. George Brebner on the Algæ of the Plymouth district. (3) "Zoology and Botany of the West India Islands." Five papers had been published as the result of the work of the Committee, and other papers were in hand on the Isopod Crustacea and Diptera. During the year much work had been done on the flora of the islands, and the Committee required a grant of £50 to aid in working out the collections already made. (4) "The Biological Investigation of Oceanic Islands." The Rev. T. S. Lea and the Rev. Canon Tristram spoke of the important work being done by the Committee, and of the necessity of its being done at once.

Friday, September 18.—The morning was devoted to a discussion on Neo-Lamarckism, Prof. C. Lloyd Morgan having undertaken to open it. Prof. Morgan, after referring at some length to the precise positions taken up by Neo-Lamarckians and Neo-Darwinians, and the difficulty of disproving either belief, said what was wanted was a really crucial case. If they could in some way exclude natural selection in some cases, and allow it to act in others, they would obtain such crucial cases; and if the habit was equally transmitted, whether natural selection was present or not, that would present an exceedingly strong point for the transmissionist. The nearest approach to such a crucial case, from his own observations, was the reaction of young birds to water. There did not seem to be any instinctive reaction to the sight of water, even on the part of ducklings. But as soon as the bill incidentally touched the water, the appropriate drinking response was at once called forth. Why did not a chick or duckling respond instinctively to the sight of something so essential to its existence as water? He had very little doubt that, under natural conditions, the mother-bird taught them to drink, and this implied that the presence of the mother, as a source of instruction, shielded the young from the incidence of natural selection. Now, though the mother could lead her young chicks to peck at the water, she could not suggest the appropriate drinking response. In this matter she did not shield them from the incidence of natural selection, and those which failed to respond to the stimulus would die of thirst, and be eliminated. Thus, when natural selection was excluded, the habit had not become congenitally linked with a visual stimulus, and where natural selection was in operation the habit had become congenitally linked with a touch or taste stimulus. Prof. Morgan concluded by saying that it was the consideration of such cases as these that had induced him to take up the Weismannian position. In the discussion, Prof. C. S. Minot said he could not defend the Neo-Lamarckian position, as the facts of embryology directly negatived it. Prof. W. F. R. Weldon deplored a metaphysical treatment of the subject. These matters could be proved or disproved by observation, and what they wanted were facts and not polemics. Mr. F. A. Bather thought the Ammonites afforded at least some proof of the Neo-Lamarckian doctrine. Prof. Hartog, Dr. Hurst, Mr. McLachlan, Sir Henry Howorth, the Rev. T. R. R. Stebbing, and Mr. E. W. McBride also took part in the discussion.

In the afternoon Mr. F. Enock read a paper on "The Life-History of the Tiger Beetle (*Cicindela campestris*)." The burrows of the larva, and how they were made, were described, and the method which the larva adopted in order to catch its prey was illustrated by some beautiful coloured lantern slides. The various changes undergone by the larva to produce the perfect insect were then outlined, and the method of egg-laying also described. It was pointed out how perfectly the larva was adapted to the conditions under which it lived, both in its anatomy and habits. The author emphasised the importance of studies of this character, and remarked that only very few of the life-histories of these animals were known in any detail. After this paper the Section adjourned to the loan museum, where a series of slides of Eozoön was exhibited by Sir William Dawson. The latter explained that upon the question of the organic or inorganic character of these remains he had still an open mind.

Mr. J. W. Woodall gave an account of Dannevig's Flodevigen hatchery for salt-water fish. This hatchery was erected in 1883, with the object of ascertaining whether it was possible to produce large numbers of the fry of the better class of salt-water fish at a reasonable cost, the decrease in the fisheries, especially the cod-fishing, having at that time been greatly felt. Difficulties had all along been a considerable bar to the work, but between the years 1890–96, 1203 millions of fry had been hatched at a cost of 0·65*d.* per 1000, whilst last season the cost had been one-third of a penny per 1000, with, it was thought, a still further chance of lowering the expenses. The hatchery cost £800, and the annual expenses were about £500. It was claimed that as a result of the operations of this hatchery the cod was rapidly increasing on the south coast of Norway, and especially at those points where the fry had been liberated. In the discussion on this paper, Dr. J. Hjort thought that ocean currents caused either the destruction or the removal of a great number of the fry liberated by the hatchery. The fry could not be kept sufficiently long in the hatchery at a reasonable expense, and if liberated before, the destruction of them must be very great. Prof. W. F. R. Weldon concurred. He wanted more evidence as to the survival of an appreciable number of the young animals when cast into the sea. Mr. Walter Garstang thought it possible that the supply of food fishes had been increased by means of fish-hatcheries. The following two papers were then read:—"On the necessity for a Fresh-water Zoological Station," by Mr. Scourfield; and "On Improvements in Trawling Apparatus," by Mr. J. H. Maclure.

The report on the "Index generum et specierum animalium" was presented by Mr. F. A. Bather. This index is being compiled by Mr. C. D. Sherborn, who has already been occupied for five years on the work, and has registered over 135,000 species. A small grant was asked for in order that this important work might be more quickly proceeded with. Mr. Bather quoted cases that had occurred in his own individual experience showing the importance of the work being carried on by Mr. Sherborn, and the Rev. T. R. R. Stebbing agreed that for systematists a complete index would be of the greatest assistance, and was becoming year by year more indispensable. The following reports were also submitted :—"On the Coccidæ of Ceylon," "On the transmission of specimens by post," and "On zoological bibliography and publication."

Saturday, September 19.—The report and discussion on the migration of birds, presented by Mr. John Cordeaux, occupied the whole of the morning, and attracted the largest meeting of the Section. The report, prepared by Mr. W. Eagle Clarke, of the Museum of Science and Art, Edinburgh, is a digest of the results obtained concerning the migration of birds as observed at lighthouses and lightships of the British Islands during the years 1880–1887 inclusive. The contents of the report had reference only to the facts obtained by the Committee, and its object was not to solve problems connected with the causes of the phenomena, the evolution of the migratory instinct, or other purely theoretical aspects of the general subject. The digest having been made from at least one hundred thousand records, it was claimed that a sufficient basis had been obtained on which a sound and proper conception of many of the phenomena of the migration of British birds could be based. The migration was treated by Mr. Clarke under the three heads of Geographical, Seasonal, and Meteorological, and a very valuable collection of facts is detailed under each section. Prof. A. Newton opened the discussion by pointing out that Mr. Clarke's labours were not by any means at an end, it being his intention to work out the migration of each species of British bird in as much detail as his data allowed. He (Prof. Newton) could wish that their observations were even more numerous, as they were still very far indeed from having exhausted the facts. Rev. Canon Tristram gave the results of some personal observations tending to show that during the day the birds flew nearer the surface and were guided by sight, whilst flying at a higher altitude during night migrations, when the difficulties of direction were evidently greater. Mr. R. M. Barrington did not think that the wind had much influence on migration. Dr. Hewetson and the Rev. E. P. Knubley also took part in the discussion.

Monday, September 21.—The morning was occupied, in conjunction with Section I, in hearing Dr. Gaskell's presidential address on the ancestry of the vertebrates, the discussion on the latter, requested by Dr. Gaskell, but unusual, taking place in the afternoon. Prof. W. F. R. Weldon, after criticising several special points in Dr. Gaskell's address, said that the great difficulty was the substitution of one alimentary canal for another. If this had been done in the way that had been suggested, they would have expected that vertebrate ontogeny would show some evidence of it ; but in no vertebrate was the pharynx formed by the coalescence in the mid-ventral line of a series of buds representing arachnid appendages. He was also not all impressed by the so-called thyroid of the Scorpion. It was easy to find such clusters of cells in many animals. Prof. C. S. Minot could not follow Dr. Gaskell with regard to the central nervous system. The formation of a tube was altogether secondary, and the central nervous system must be described as being originally solid. Further, the origin of both the epithelium lining the neural canal, and the surrounding nervous material, was the same, and this would not be the case if Dr. Gaskell's hypothesis were correct. He therefore differed from Prof. Weldon, who had seen no special difficulty in this part of Dr. Gaskell's address. Mr. E. W. McBride pointed out that if the vertebrate alimentary canal was phylogenetically more recent than its nervous system, ontogeny would of necessity bear out Dr. Gaskell's conclusions. This, however, it did not do. The alimentary canal was always formed first, and the nervous system afterwards. Mr. McBride further, in maintaining that the invertebrate and vertebrate alimentary canals were homologous, stated that in the Decapod *Lucifer*, in which segmentation was not affected by yolk, the formation of the alimentary canal was essentially the same as in vertebrates. He maintained that this objection was absolutely fatal to Dr. Gaskell's theory. Mr. Walter Garstang said that two alternative theories of vertebrate ancestry had been mentioned by Dr. Gaskell, but there was also another which required respectful consideration. That was that the vertebrate nervous system had been formed by the coalescence of lateral cords. He maintained that there was considerable evidence in favour of this. Mr. W. E. Hoyle thought that Dr. Gaskell had been misled by the superficial resemblances of adults, and had not attached enough importance to the early stages. Mr. F. A. Bather stated that palæontology afforded no evidence for Dr. Gaskell's theory. It was very extraordinary, if the vertebrates had been preceded by a series of *Limulus*-like animals having a skeleton of the most imperishable substance known, that absolutely no traces should have been left of these animals in the fossiliferous rocks. Dr. H. Gadow, Prof. A. M. Paterson, and Prof. S. J. Hickson, also took part in the discussion.

As having some bearing on the above discussion, Dr. R. H. Traquair gave an account, illustrated by the original specimens, diagrams, and a model, of the remarkable fossil *Palæospondylus Gunni*. He insisted on its Cyclostome affinities, and expressed his belief that Dr. Bashford Dean's pectoral fin did not belong to the fossil at all. He had examined hundreds of specimens, and had seen no traces of it.

Tuesday, September 22.—The Section was occupied in the morning, in conjunction with Section K, with a discussion on the cell theory, an account of which will appear in the report of the Botany Section. Prof. C. S. Minot read a paper "on the theory of panplasm." He agreed with Bütschli in regarding protoplasm as a mixture of two fluids, similar in nature to an emulsion of oil and water. There was no evidence to show that vital functions were localised in small particles, and that each particle in itself was a unit of living material, and with a number of other such particles went to constitute the protoplasm of a single cell. He supposed that all the materials of the cell by their interaction produced living protoplasm, and that therefore the particles were mutually dependent. Hence the name panplasm. Prof. E. Zacharias thought that the study of living protoplasm was one which would produce valuable results, and had been too much neglected. He did not think protoplasm had a fibrillar structure, and such statements usually rested on an insecure basis of fact. Prof. M. M. Hartog then read a communication on the "relation of multiple cell-division to bipartition at the limit of growth," in which Herbert Spencer's explanation of bipartition was criticised and a new view expounded.

In the afternoon Mr. E. W. McBride opened with a paper on "the value of the morphological method in zoology." He stated that for some time back a distrust of the morphological method of studying evolution had been growing up amongst zoologists, and several alternative methods had been proposed. All of these, however, had their drawbacks. The reason of the discontent with the morphological method was that it proved too much, and the most contradictory conclusions were to be drawn from the same premises. Several suggestions were offered as to better ways of dealing with morphological facts. It was a gratuitous assumption that similarity in broad outlines of structures which were adaptive indicated descent from the same species. Structural resemblance indicated not primarily identity of ancestry, but similarity of past environment ; and there might be all degrees in this similarity, both in extent and duration. Such a conclusion was tacitly admitted by systematists who made the basis of their system minute and apparently unimportant peculiarities of external form, colour, or arrangement of similar organs. It was, however, the origin and history of adaptations which interested the morphologist, and his task must be not primarily to draw up genealogical trees, but to correlate adaptations as far as possible to the external conditions which had caused them. Mr. F. A. Bather largely followed the conclusions of Mr. McBride. A great deal of misconception had arisen on account of general conclusions having been drawn from the study of specialised types. As an instance of this he cited the case of the Crinoid *Antedon*, which was a most specialised form, and yet had done duty for a primitive type. Morphologists should be more careful in the selection of their types if they wanted to base general conclusions on their results. Prof. F. Y. Edgeworth then read a paper upon the habits of wasps, showing how statistical methods could be utilised with success in the study of the migrations and other movements of animals such as wasps and other insects.

The following business concluded the proceedings for the day : Prof. C. S. Minot read a paper on the morphology of the olfactory

lobe; a report by Mr. J. E. S. Moore was presented on the fauna of the African lakes; Prof. M. M. Hartog read a paper on the Morphology of the Rotifera and the Trochophore larva; and a letter was read by Prof. A. Newton from Dr. Stirling, on *Genyornis Newtoni*, an extinct Ratite bird from Australia allied to the Emu, but with leg-bones like those of the Moa, supposed to belong to the order *Megistanes*.

Wednesday, September 23.—The first paper of the final meeting of the Section was by Mr. A. T. Masterman on "*Phoronis*, the earliest ancestor of the Vertebrates." Mr. Masterman described two diverticula of the gut in the Actinotrocha larva, which he concluded from their structure represented a double notochord. He hence proposed a new group, to be called the Diplochordata. Hence the supposed relationship of *Phoronis* to the primitive vertebrate was confirmed. Mr. E. W. McBride said that there was such a strong tendency to discover ancestors for the Vertebrata, that great caution should be exercised before needlessly adding to the list. He thought that a double notochord was too great a demand upon their credulity, although Mr. Masterman's diverticula might function as a notochord.

Prof. W. A. Herdman then read a report on the Zoology, Botany, and Geology of the Irish Sea (illustrated by the lantern). A very interesting account was given of the work done by the members of the Liverpool Marine Biology Committee and other naturalists, and slides were shown of the Laboratory at Port Erin and its surroundings. The Committee were doing a useful work, and a work which was very far from being complete. The Rev. T. R. R. Stebbing spoke of the admirable faunistic work being done by the members of the Committee, and thought that they were to be congratulated on their report. Mr. W. E. Hoyle thought the results obtained by Prof. Herdman and his colleagues had an important bearing upon questions of general oceanography, and it was to be hoped, therefore, that the work of the Committee would not cease. Prof. Johann Walther testified to the admirable work that had been done in British seas during the last fifty years. This work, which was so important to marine biologists and oceanographists, had been initiated by Edward Forbes, and continued by Prof. Herdman, whom he regarded as Forbes' natural successor. Dr. Hjort and Mr. A. O. Walker also took part in the discussion.

Mr. Masterman read a further paper on "Some Effects of Pelagic Spawning on the Life-Histories of Marine Fishes," in which he maintained that pelagic spawning was more primitive than littoral. This explained many well-known facts in the migration of fishes. Dr. W. B. Benham then read a short paper on the structure of the genital glands of *Apus*, which, he asserted, could not be described as an hermaphrodite. He had recently made some observations on the reproductive organ of a male *Apus*, and showed diagrams of the spermatogenesis. The specimen had not been well preserved, but, except in this respect, he believed he was the first to study the testis of *Apus* according to modern methods. After some remarks by Prof. Hartog, the meeting concluded with a paper on the life-history of the Haddock, by Prof. W. C. McIntosh, communicated by Mr. Masterman.

MECHANICS AT THE BRITISH ASSOCIATION.

THE meetings in Section G—that devoted to mechanical science—at the recent Liverpool meeting of the British Association were generally well attended, and, on the whole, the proceedings compared not unfavourably with those of recent years. But only qualified praise can be given, as for long "G" has fallen short of its vocation. We look back to past times, to the days of Rankine and Froude, when the Section was more constant to its true mission, and sigh over later records. Mechanical science, though only applied science, *is* science; and though the Section must be utilitarian, it need not be a penny-readings or a means of trade advertisement. We think that any one acquainted with the proceedings of later years will agree that both the latter elements have been too much in evidence. With regard to the penny-readings or popular-lecture side of the question, we had more than one example during the recent meeting. There were some most interesting lectures and discourses, illustrated by equally interesting lantern slides, but they could hardly be classed as scientific They were just admirable penny-readings—nothing more.

With regard to the second undesirable feature to which reference has been made, we feel we are on delicate ground. A man having made an invention of a useful nature, and translated it into a machine or a process, naturally wishes to bring it prominently before the world for financial reasons. A cheap and efficacious method of doing so, is by reading a paper before a technical society. That is a perfectly legitimate proceeding, and is thoroughly recognised by the various societies and institutions of this nature; for however much they may strive to pose as scientific, they know well enough they are no more than technical, and founded on commercial bases. Were it not for the hope of advertisement—it is best to call spades, spades—not one half the papers read before engineering societies would ever be written; but that is no reproach to the societies. They do most admirable and useful work, without which the country would not make the progress it does. The morality of technical societies is, as it should be—"If a man has anything new and instructive to tell us, he is entitled to his advertisement, short of introducing purely commercial details."

But the British Association for the Advancement of Science should take higher ground than this, even in Section G. It should not allow a paper to be read on a trade article at the same time that illustrated catalogues and price-lists of the article are distributed amongst the audience. Neither should it allow its officials to distribute among the audience touting circulars asking members present to subscribe to a public company which bears evidence of being a trade association.

There were, however, at the recent meeting one or two good examples of the work Section G ought to do. Mr. Beaumont's paper may be taken. It was an endeavour to account for a somewhat obscure, but well-known, engineering phenomenon by the aid of scientific or physical data. The author may have been wrong in his conclusions, even in his premises, as some speakers during the discussion suggested, but at any rate he had a proper conception of what a British Association paper should be, and some regard for the dignity of the Section. Mr. Wheeler's report on tidal influences was also a piece of good work, which will be useful to those making scientific investigation of the subject; and there were one or two other items in the programme of a character proper to the Section; but we will proceed to details.

This year Sir Douglas Fox was President of the Section, and on Thursday, September 17, the proceedings were opened by his inaugural address. This we have already printed in full. The first paper taken was by Mr. G. F. Lyster, and was on the "Physical and Engineering Features of the River Mersey, and the Port of Liverpool." This was not a contribution of the popular-lecture order, because it was not popular, and it was certainly not a "mechanical science" paper. It could hardly be called an engineering paper, excepting in respect of it being a catalogue of engineering works. It was very long, and its author read it to the bitter end. It is to be printed in the *Proceedings*.

Mr. Beaumont's paper, to which reference has already been made, came next. The following is an abstract of this contribution. The author was of opinion that the failure of any rail, however perfect, is chiefly a question of the number and weight of the trains passing over it. The result of the rolling of the heavily loaded wheels of engines and vehicles is that a gradual compression of the upper part of the rails takes place, and this produces internal stresses which are cumulative and reach great magnitude. That which takes place in the material of a rail head under the action of very heavy rolling loads at high speed, is precisely that which is purposely brought into use every day in ironworks. The effect is, however, obscured by the slowness of the growth and transmission of the forces which are ultimately destructive. It was pointed out, further, that when a piece of iron or steel is subjected to pressures exceeding the limit of elastic compression, by a rolling or hammering action, or by both these combined, the result is spreading of the material and general change of the dimensions. This is equally the case with a plate hammered or rolled on one side while resting on a flat surface. In these cases, the hammering or rolling work done upon the surfaces tends to compress the material beneath it, but being nearly incompressible and unchangeable in density, the material flows, and change of form results. Generally the material thus changed in form suffers permanently no greater stresses than those within its elastic limit of compression or extension. When, however, the material is not free to flow or to change its form in the directions in which the stresses set up

would act, the effect of continued work done on the surface is the growth of compressive stress exceeding elastic resistance.

In the case of railway rails the freedom for the flow of the material is very limited. Hardening of the surface takes place, and destructive compression of the surface material is set up. If the material be cast iron, the destructive compression causes crumbling of the superficial parts, and the consequent relief of the material immediately below it from stress beyond that of elastic compression; but when the material is that of steel rails, the stress accumulates, the upper part near the surface being under intense compression, differentiating from a maximum at the surface. This compression gives rise to molecular stresses, analogous to those which, on the compression side or inner curve of a bar bent on itself, originate traverse flaws on that side. This condition of compression exists along the whole length of a rail, so that when its magnitude is sufficient to originate crumbling or minute flaws, any unusual impact stress, or a stress in the direction opposite to that brought about by the usual rolling load, the rail may break into two or into numerous pieces. Stresses originating in the same manner explain the fracture of railway tyres as described fully by the author in the "Proceedings of the Institution of Civil Engineers," 1876, vol. xlvii.

A good discussion followed the reading of this paper. It was opened by Prof. Unwin, who took a somewhat different view from that of the author. The latter, the speaker pointed out, attributed the ultimate failure of a rail to the number of trains which passed over it; but his, the speaker's, experience told him that there was most danger in new rails. Again, according to the paper, one would expect soft rails to give way more quickly than hard ones; but here again experience negatived the assumption. A defect in the paper, however, was that the author had neglected to consider the composition of the rail, and this was the governing factor. Other points to which the speaker made reference were fatigue, and the change from a homogeneous to a non-homogeneous material. It was well known that a rail might be used in one way for a considerable time, but that when turned over it would be liable to break, and the speaker further illustrated his point by the analogy of a punched hole; but in this case one part was put in tension, so that annealing removed the defect. These things, however, did not solve the problem, and in his opinion work put upon the rail in use strengthened rather than weakened it; but the initial condition had far more influence than the rolling of wheels.

Mr. Johnson, of the Midland Railway, had strips taken from various parts of broken rails, and did not find difference in composition. Fractures had undoubtedly occurred through rails being made from a "piped" ingot—that is to say, one in which the whole of the head and pipe, in which the impurities collect, had not been sufficiently removed.

Dr. Anderson, Director-General of Ordnance Factories, pointed out the similarity of the effects described by the author in the case of rails and those observed in big guns which had been much fired. In the bore of guns a large number of minute cracks were discovered, and the deterioration of the A tube of a gun was due to the powder gases breaking out the squares. Here there was ultimate compression and release of pressure, as in a rail.

The President had examined rails which had failed, by the microscope, and had noticed the minute cracks referred to. He would point out that rails often gave way at the ends, and this bore out the theory that defects were caused by insufficient cropping leaving the "pipe." He pointed out that a crack once started might easily be extended by lower strains than would be required to start it; just as a tear or rent commenced on a piece of paper would be easily continued. Prof. Hele-Shaw pointed out that if the rail were planed, the latter defect would be removed. It may be worth putting on record that the late Mr. Spooner, chief engineer to the Festiniog Mountain Railway, who used to turn his rails at times, once told us that an unplaned rail was more liable to break than one which had been planed. Of course the object of planing was not undertaken with a view to prevent breakage, but to take out the dents from the chairs; but the result stated had been observed.

In replying to the discussion Mr. Beaumont stated, in regard to Prof. Unwin's remarks, that he, the speaker, had submitted facts, and not speculations, to explain breakage of rails. The Board of Trade inquiry on the subject had proved that there was a good deal to learn, and he had mainly put forward his paper with a view to raising discussion. He could produce figures tending to show that sometimes the hardest rails lasted longest, though when they did give way they were apt to break into a greater number of pieces. Undoubtedly the rail must be of good steel—not impure—to do its work properly; that, he had concluded, was a foregone conclusion. The question of the rail forming a continuous girder affected the matter of end breakage, and in this respect the influence of the modern stiff fish-plate had to be considered.

On the following day, Friday, September 18, the proceedings opened with the report of the Sectional Committee appointed to consider the effect of wind and atmospheric pressure on the tides. The members of the Committee were Profs. L. F. Vernon-Harcourt and W. C. Unwin, Messrs. G. F. Deacon and W. H Wheeler. The latter acted as secretary, and drew up the report. Information had been obtained from various ports in England. It was concluded, firstly, that the tides are influenced both by atmospheric pressure and by the wind to an extent which considerably affects their height; secondly, that the height of about one-fourth the tides is affected by wind; thirdly, that the atmospheric pressure affecting the tides operates over so wide an area, that the local indications given by the barometer at any particular spot do not afford any trustworthy guide as to the effect on the tide of that particular port; fourthly, that although, so far as the average results go, there can be traced a direct connection between the force and direction of the wind and the variation in the height of the tides, yet there is so much discrepancy in the average results when applied to individual tides that no satisfactory formula can be established for indicating the amount of variation in the height of the tide due to any given force of wind; fifthly, the results given in the tables attached to the report relating to atmospheric pressure indicate that the effect of this is greater than has generally been allowed, a variation of ½ inch from the average pressure causing a variation of 15 inches in the height of the tides. As the report will be printed in full in the published *Proceedings* of the Association, we have thought it unnecessary to give more than the conclusions reached, but the whole is well worthy of the attention of those interested in the subject. Mr. Wheeler is well known as a trustworthy and diligent student of this question, and his professional status enables him to obtain information from a wide source.

A brief report on the calibration of instruments in engineering laboratories was the next item in the programme. Copies of this report, so far as we could ascertain, were not distributed.

Mr. Barry's lecture on the Tower Bridge followed, and attracted a large audience. It was interesting, and the lantern slides were well managed. Mr. J. Parry followed with a long paper of the historical-record order, dealing with the Liverpool Waterworks. The last item on this day was a contribution by Mr. A. J. Maginnis, entitled "The present position of the British North Atlantic Mail Service." It was a good paper in its way, but its way was not quite that of mechanical science; indeed, the author dwelt rather on the economics of ocean service than on its engineering aspects. Some instructive figures in regard to coal consumption were given, it being stated, among other things, that the *Campania* burns 20 tons of coal per hour. To drive an improved *Campania*, 700 feet long and 74 feet wide, 23 to 24 knots would require 46,000 indicated horse-power, supposing existing practice were followed. The cost of the vessel would be £800,000.

The next sitting of Section G was held on the Monday following, September 21, and was, according to custom, devoted to electrical engineering. The first business was the reading of a report by the Committee on small screw gauges. This report has been looked forward to with interest for some time. It will be printed in full in the *Proceedings* of the Association. Mr. Preece (the chairman of the Committee) drew up the report. After giving details of the method of work followed by the Committee, and referring to the labours of others in the same field, the report proceeded to notice a method, suggested by Colonel Watkin, for making very accurate comparison. There would be thrown, side by side on a screen, photographic images of the screw to be examined, and of the standard with which would be compared, together with the image of a scale which might be divided to one ten-thousandth of an inch. The images of these three objects being so close to one another, a comparison to a very high degree of accuracy could be made. Mr. Price, a member of the Committee, submitted a microscopical method, in which the screw to be

measured is attached to the stage of the microscope, the traversing slide of which is provided with a vernier scale, while a vernier cross-hair in the eye-piece forms the index of the instrument. When the microscope has been adjusted for clear focus, the screw is traversed across the field until the cross-hair intersects the thread of the screw at the desired point. The traversing screw of the slide is then turned until the corresponding point of the next thread is intersected by the cross-hair, and the reading of the vernier on the scale gives the measurement of the pitch with great accuracy.

The Committee decided that gauges for ordinary workshop use would be best tested, as regards pitch and form of thread, by a template or "comb," the accuracy of which would be verified by the photographic method. External dimensions could be obtained by micrometer gauge, and the internal diameter, or core, by a gauge suggested by Mr. A. Stroh, a member of the Committee, the details of which have yet to be worked out. The Committee failed to discover any very trustworthy method of testing a female standard gauge. Naturally a mathematically accurate male gauge cannot be screwed into a mathematically accurate female gauge of like dimensions, but the variation should not exceed a "good fit." A table prepared by Prof. Le Neve Foster, dealing with this subject, was added as an appendix. The details given refer to works managers' gauges. Those used by the workman or foreman need not possess the mathematical accuracy of the standard gauges. For full details of this useful report, we must refer our readers to the published *Proceedings* of the Association, where it will be found printed together with the illustrations necessary for its full comprehension.

A long paper, by Mr. W. H. Preece, on "The Tests of Glow-Lamps," followed. It comprised the results of a very large number of tests, the details being given in diagrams handed round at the meeting. It would be impossible here to give even a summary of the results of tests, for the lamps tried were supplied by a number of makers, and varied according to the numerous conditions of trial. Some of the cheaper lamps gave results not at all in accordance with what would be expected from them if the statements of the makers were to be taken as guides. The experiments tended to prove that in continuous lighting for 1000 hours the candle-power fell about 30 per cent., and the watts per candle-power rose about 28 per cent. Lamps for installation work of about $3\frac{3}{4}$ watts per candle-power, burning from seven to nine hours per day, behave, as regards life and efficiency, about the same as when giving continuous illumination; but high efficiency lamps deteriorate more quickly. Good 100 to 105 volt 16-candle-power lamps, taking $3\frac{3}{4}$ volts per candle, should stand a gradual increase of pressure of direct current up to 225 or 280 volts in $3\frac{1}{2}$ minutes before the filament breaks. When the pressure is regularly raised in $2\frac{1}{2}$ minutes to 170 volts, and afterwards re-tested at ordinary voltage, the candle-power should not be less than 14·4, nor higher than 17·6, while the watts per candle should not exceed 4. The author also suggested in his paper a quick and ready way of satisfactorily judging the quality of lamps. To obtain this end the voltage of several lamps was gradually run up for each lamp singly at a uniform rate until the filaments broke. At the moment of rupture the voltage, current, and time of running up were noted. Before increasing the normal voltage the current was measured and the resistance calculated. The average breaking voltage of the filaments was found to be 230, and the time of running up was $3\frac{1}{2}$ to $4\frac{1}{2}$ minutes. Mr. Preece also gave a standard specification for glow-lamps which he had drawn up for use in the Post Office.

Prof. Ayrton, in the discussion on the paper, said that it was to be expected, as noticed by the author, that lamps which gave at first less than their nominal candle-power would last longer, as they were worked at a lower pressure. He pointed out that certain figures given by the author as to the cost of illumination by glow-lamps showed electricity to be dearer than gas burnt in an Argand burner, and very largely in excess of gas burnt by the Welsbach system. It had been noted that the illuminating power had gone up in certain glow-lamps, though the voltage remained constant. That was an interesting point, and one difficult to account for. It had been thought that the improvement was due to improved vacuum, but this was hardly to be believed, and he suggested it might arise from improvement of the filament during use. Prof. Fleming referred to the unsatisfactory nature of the standard candle, and also to the importance of personal error in photometric investigation. Mr. Swan approved of the short test suggested by the author, and pointed out that the length of life of a lamp depended upon constancy of pressure, a thing often much to be desired in central stations. Mr. Preece, in replying, said that though gas might be cheaper per hour than electricity, yet the ease with which the latter was turned on and off led to less light being wasted, and therefore an equality of cost was produced. If, however, local authorities would use electricity for tram propulsion, the cost of electric light per hour would be brought greatly below that of gas, in consequence of equalisation of the load factor.

A paper by Mr. S. B. Cotterell, on the "Liverpool Overhead Railway," was next read, in which the author described the engineering and other details of this construction. Mr. E. W. Anderson also read a paper on "Electric Cranes," the author expressing opinions favourable to the application of electric power for lifting heavy weights. Papers on "Hysteresis," by Prof. Fleming, and on "Street Lighting," by Mr. Walker, were also read.

The Section had a long sitting on the Tuesday of the meeting, but some of the papers were not of great importance. The first taken was by Captain Jaques, of New York, and was on "Armour and Ordnance." It was devoted largely to showing the great superiority of the United States over the rest of the world in the field. A spherical balanced valve was described by its inventor, Mr. J. Casey. It is an engineer's fitting involving an application of known principle. Prof. Hele-Shaw next gave an interesting description of certain instructional apparatus used in the Walker Engineering Laboratory, including Froude's dynamometer break, the speaker giving an excellent popular description of this ingenious appliance. A good discussion on the subject of technical education followed, in which, among others, Profs. Perry, Beare, Schröter (of Munich), Ritter (of Zürich), Merrivale, and Hele-Shaw took part. The opinion was expressed that the course of instruction proposed for the establishments known as Polytechnics, which have been so plentifully started in this country of late, is too ambitious, and the apparatus so complicated that evening students have not either time or ability to take advantage of it. Papers on "Colour Printing," by Mr. T. Cond, and on "Expanded Metal," a species of network made by slitting metallic sheets, were also read. The last sitting of the meeting was held on Wednesday, September 23. A paper by Mr. J. Bell described a system of wreck-raising, which the author and others had worked out. Lifting pontoons are employed in the ordinary way, but in place of the rise of tide being used to raise the wreck from the bottom, winches are adopted. The details of construction were illustrated by models. Finally a lecture on "Motor Carriages," by Mr. Sennett, was given. It was of an entirely popular character.

This brought the proceedings in Section G to a close.

ANTHROPOLOGY AT THE BRITISH ASSOCIATION.

AFTER the President's Address (*cf.* NATURE, October 1, p. 527), the remainder of Monday was devoted to papers dealing with Prehistoric Archæology. Mr. Seton Karr exhibited specimens and photographs of the palæolithic implements which he had collected in Somaliland; these form an interesting link in the series of finds extending from India to Britain. It is well known that ordinary palæolithic implements of the river-gravel type are wanting in Ireland; but Mr. W. J. Knowles contends that the older flint implements he has found in the north-east of Ireland belong to this epoch, and that some bear striæ which "have been pronounced to be glacial." A discussion arose in the afternoon, in connection with some photographs of dolmens in Brittany exhibited by Prof Herdman, as to the age of such structures. Prof. Boyd Dawkins maintained that they belonged to the Bronze Age, while Dr. Montelius, Dr. Garson, and others recognise that they are essentially Neolithic.

The proceedings on Friday commenced with speeches by the President, Sir William Turner, Prof. A. Macalister, and Mr. Brabrook, in commemoration of the centenary of the birth of Prof. A. Retzius, who was the originator of some of the modern methods of craniology, and who did a great deal to stimulate anthropological science in Scandinavia. Mr. A. W. Moore and Dr. J. Beddoe read a joint communication on the physical anthropology of the Isle of Man as analysed from the "Description Book of the Royal Manx Fencibles," in which are contained particulars of 1112 Manxmen enrolled between 1803 and 1810. Speaking roughly, there are

three ethnic districts: in the north-west the stature is highest, but dark hair and eyes are least prevalent; dark hair, coupled with grey eyes, is most abundant in the somewhat infertile parishes of Maughold and Lonan; while dark eyes are comparatively frequent in the central parishes where the Scandio-Gaelic stock is probably less pure. The chief paper of the day was an elaborate study of the Trinil femur, by Dr. D. Hepburn. The femora of various savage and civilised races were compared with that of *Pithecanthropus erectus.* The author dealt especially with the popliteal space, and followed the methods adopted by Manouvrier; in fact, this paper was largely an extension of the French investigator's careful study. He noted the absence of symmetry between two femora of the same individual, and exhibited an Australian femur with the same popliteal measurements and index as those of the Trinil femur. The condyles of the Trinil femur are human, and not simian. The author stating that the distinguishing features of the Trinil femur are found singly and in conjunction on human femora, with sufficient frequency to enable them to rank as human characters; and thus its features do not entitle it to the distinction of a separate genus, but it is a true human femur, although of very ancient date. This paper led to a good discussion, in which several speakers took part Prof. Boyd Dawkins did not regard the Trinil find to be of Pliocene Age. Dr. Garson believed that these specimens belonged to a new genus and species of the Hominidæ. Sir John Evans reserved his judgment; this he summed up in his felicitous manner in the following rhyme, which was not, however, uttered in public:—

About three things pray let us have the truth—
The skull, the thigh bone, and the Trinil tooth.
The thigh is human, does the skull belong?
Is the tooth human, or is Dubois wrong?
But, after all, where were the relics found—
Was it in ancient or in modern ground?

Dr. Garson exhibited a lantern slide of an outline figure which embodied the mean proportions of the head, body, and limbs of the members of the British Association who have been measured at the various meetings. In the afternoon Mr. F. T. Elworthy gave a fully illustrated lantern demonstration of the survivals in modern South Italian charms from very ancient Pagan times.

On Saturday morning Mr. Brabrook presented the Report of the Ethnographical Survey of Great Britain and Ireland, which showed that the survey is steadily progressing. There were several appendices to this report, the two most important being Dr. W. Gregor's, on Galloway folk-lore, and one by Mr. Gomme, on the method of determining the value of folk-lore as ethnological data. This was a solid and novel contribution to the right apprehension of folk-lore, which deserves to be widely read; it consisted mainly of an analysis of fire rites and ceremonies in the British Islands. Among these numerous customs nine are reckoned as constituent elements, two are suggestive of the original culture stage (the use of stone implements), while eight are divergent elements. If lines are drawn on a map connecting the localities where more or fewer of these customs occur, an "ethnological test-figure" is arrived at for each country. These fire customs are held to be of Aryan origin. Mr. Gomme has previously stated reasons for considering water-worship customs to be non-Aryan in origin; to belong, therefore, to the pre-Celtic people of these islands, and the "ethnological test-figure" produced by mapping the occurrence of water customs, differs radically from that connected with fire customs.

Mr. C. H. Read urged the formation of an Ethnological Bureau for this country, analogous but not similar to the famous Bureau of Ethnology in the United States. He recognised that a certain amount of partial or isolated work was being done in India and elsewhere, but what was wanted was a uniform system of inquiry extending all over our possessions, and the collection and collation of the results in a central office. He recommended (1) that the reports should be systematised and on a uniform method, (2) that such work should be held to be part of the duties of the local Government officer, and consequently (3) the officer should obtain credit for such work when well done. In conclusion, he repeated, "a nation having under its Government or protection so many primitive or uncivilised races, as are now within the confines of the British Empire or upon its borders, is bound both by interest and policy to study and to put on record all facts connected with their history, beliefs, and manners and customs, the knowledge of such facts being, in the first place, essential to the maintenance of peaceful and friendly relations, and, in the second, of the highest interest to science." The proposition was warmly supported by Profs. Macalister, Boyd Dawkins, Haddon, and Sir John Evans. In his paper on "Anthropological opportunities in British New Guinea," Mr. S. H. Ray re-affirmed the danger of delay in investigating the anthropology of British New Guinea, and called attention to the opportunities which exist for successfully carrying it out. If anything is to be done, it should be done soon. Stress is laid upon languages as folk-lore; religious beliefs and practices and legal customs can only be thoroughly studied through the medium of the languages. We want to know the native's reason for his thought and practice, as the European often draws most erroneous conclusions from his own observations. The country is now quiet and safe, and facilities would doubtless be offered by the present enlightened administrator, Sir Wm. MacGregor. Prof. Haddon followed with an earnest appeal for the immediate investigation of the anthropology of all islands and other districts where the indigenous population is being exterminated or largely modified by the advent of the white man.

Monday morning was devoted to a discussion of the origin of the knowledge of copper and iron in Europe. This was led off by Mr. J. L. Myres, who indicated the part played by Cyprus and its relation to the trade routes of South-east Europe. Dr. J. H. Gladstone gave a series of analyses of prehistoric metal implements, which demonstrated a transition for the use of pure copper to the widely-spread bronze; various methods for hardening the copper were employed, such as the sub-oxides of copper and various natural alloys of copper with antimony and arsenic, but when the tin bronze was discovered it quickly superseded all the others. An interesting discussion followed, in which Dr. Munro maintained that there was no proof of a Copper Age in Europe, the copper implements being "starved" bronze, and only manufactured when the supply of tin ran short; but this view did not gain general support. Prof. Ridgeway read a paper on the starting-point of the Iron Age in Europe, in which he pointed out that Hallstatt, in Austria, is the only place in Europe where articles of iron are found gradually replacing those of the same kind made in bronze, and that within a very short distance of the Hallstatt cemetery lies one of the most famous iron mines of antiquity, Noreia. He suggested that the accidental finding of an outcrop of volcanic iron, such as that known in at least one place in Greenland, led to iron smelting: there is no need to suppose that meteoric stones first supplied man with that metal. This theory was adversely criticised by several speakers. Mr. Myres gave an abstract of Sergi's theory of a Mediterranean Race (this subject has already been referred to in our columns). It was a disappointment to many that Prof. Sergi was unable to fulfil his promise to be present and explain his views. Dr. Munro and Prof. Boyd Dawkins detailed at length the results of the recent excavations of the Lake Village of Glastonbury. A model of accurate archæological research was afforded by Dr. Stolpe, of Stockholm, in his account of the Vendel finds in Sweden. These boat graves ranged from a period of about 600 to 1000 A.D., and various modifications were noted during that period; numerous beautiful drawings and lantern slides of the bronze objects found were exhibited. Mr. R. A. S. Macalister gave an interesting account of a recent exploration he had made of a prehistoric settlement in Co. Kerry, which was illustrated by numerous lantern slides.

A great discussion on the early civilisation of the Mediterranean was opened on Tuesday morning, in a fine fighting speech by Prof. Ridgeway, entitled "Who produced the object called Mykenæan"? The genial Irishman made a brilliant onslaught on many generally recognised views. The credit of this civilisation belonged either to the Achæans or to the Pelasgians. The traditions of the Greeks themselves point to the latter. The age of Mykenæ is that of Bronze, that of Homer's Achæans is distinctly of Iron. Engraved gems are characteristic of Mykenæ, but these were unknown to Homer; but the converse is the case with fibulæ. The Mykenæans had a peculiar figure of 8 shield, no breastplate, no metal greaves, and they wore their hair in three locks behind; whilst the Achæans had round shields, bronze breastplates and greaves, and wore their hair flowing. There is no need to cut Homer to pieces to fit the Mykenæan Age; this culture is that of the Bronze Period and Pelasgian in origin, and was supplanted by the Iron Age, which was introduced by the Achæans into Greece. Prof. Petrie supported Prof. Ridgeway by adducing the argument of a continuity of artistic pre-eminence from Mykenæan times to the art of Pheidias in Attica, which was a Pelasgian settlement. Dr. Beddoe pointed out that the skull-form of Pericles and other noted Greeks was Pelasgian in

character. Principal Rendall strongly supported the orthodox classical view of Reichel and Leaf, and scoffed at the "Pelasgian heresy." Dr. Munro, Sir John Evans, and Mr. Myres continued the discussion; the latter ingeniously showed how a round shield could be twisted into a figure of 8. The President also spoke, and Prof. Ridgeway replied to the criticisms; and so terminated one of the most lively and interesting debates that Section H has ever experienced. Dr. O. Montelius gave a characteristically careful and learned paper on pre-classical chronology in Greece and Italy, in which he distinguished four divisions of the Bronze Age in North and Central Italy, dating from 2100 to 1100 B.C., two Protetruscan Periods, from 1100 to 900 B.C., in Central Italy, and two Central Italian Etruscan Periods from 900 to 700 B.C. The forms of the implements, fibulæ, pottery, &c., that characterised these several periods were fully illustrated by lantern slides. He stated that the copper implements were made in the same shapes as those of the old stone implements. Prof. Petrie referred to a recent discovery of his own, in Egypt, of iron tools of such a character that they must have been made by a people long acquainted with iron; they were associated with an Assyrian helmet which can be dated about 670 B.C. This is the oldest known datable iron find. The beginning of the use of copper tools in the Mediterranean area was from 3500 to 3000 B.C. The President read a paper on pillar and tree worship in Mykenæan Greece, as illustrated by signets, on a gold ring from the early Mykenæan Period (about 1500 B.C.) a dual cult of a male and female divinity in their pillar shape is engraved. Other signets show deities as pillars and trees enclosed in small shrines; the cult of the fig-tree and the early sanctity of the dove were referred to; and attention was also drawn to the fact that pillar and tree worship of Mykenæan Greece is seen largely to survive in the rustic cult of classical Greece. Mr. G. Coffey gave a lucid account, illustrated by lantern slides, of the relation of the stone-carvings of the tumuli of New Grange, Dowth and Loughcrew to Scandinavian art. He has lately discovered in Dowth the representation of a boat identical with those inscribed on Swedish rocks; this is the first undoubted example found outside Scandinavia. Other new evidence was brought forward to substantiate his view of a direct borrowing of Norse motives, many of which in their turn had come into Scandinavia from the Mediterranean up the valley of the Danube, and round Hungary. Mr. Kermode concluded a long and very interesting day's work by describing a magnificent series of rubbings and drawings of Celtic and Scandinavian crosses from the Isle of Man. In a recent number (*cf.* NATURE, October 8, p. 547) we have referred to the appreciation by numerous members of the Association of Mr. Kermode's endeavours to preserve and record these beautiful and most interesting remains.

Prof. Flinders Petrie brought forward on Wednesday his scheme of an ethnological and archæological storehouse. Most of the speakers who followed admitted that more room was needed than most existing museums can possibly afford if large collections were to be preserved intact, and it was also recognised that long series of objects were necessary for scientific study. Certain details of his proposed museum were criticised, but Prof. Petrie thought that all these could be met.

An interesting paper on "The Duk-duk and other Customs as Forms of Expression of the Melanesian's Intellectual Life" was read by Graf von Pfeil. During his long stay in the Bismarck Archipelago he came to regard the natives' strong desire for physical and psychical seclusion as an explanation of some of their ceremonial customs. They still hate the white man, and distrust their fellow countrymen. The Duk-duk apparently serves to propitiate evil spirits and to levy blackmail on non-initiates. The Eineth and Marawot ceremonies were described for the first time; the former appears to be related to ancestor worship, and taboos are placed on various foods, actions and words. Little, however, is as yet known about this or the Marawot; the latter consists mainly of a dance on a high platform. The author urged the immediate importance of studying the habits of the Melanesians, owing to the change which is taking place. In the discussion which followed, Mr. Hartland and Prof. Haddon suggested that there was more behind these ceremonies than the author had yet discovered, but he was congratulated on approaching the subject from a psychological point of view. The Count maintained his view that the Melanesian was very largely actuated by mercenary motives.

Mr. F. T. Elworthy announced the very recent discovery of an Ancient British interment in Somersetshire, which led to a long discussion, the net result of which appeared to be that this was a burial, in a stone cist and with a decorated earthen vessel of the Neolithic type, of a man who, by his skull, undoubtedly belonged to the Bronze Race.

This session was one of the most successful of any meeting of Section H. Most of the papers maintained a high level, and the pre-arranged discussions proved an interesting and instructive feature. Numerous distinguished foreigners had expressed their intention of being present, but, unfortunately, only Drs. O. Montelius and H. Stolpe, and Prof. W. H. Goodyear actually arrived.

FORTHCOMING BOOKS OF SCIENCE.

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The announcements of Messrs. Macmillan and Co., Ltd., include:—"The Log of a Naturalist in West Africa (Congo Française, Corisco and Cameroons)," by Miss Mary Kingsley, with illustrations and a map of the Congo Française; "The Cambridge Natural History," vol. ii., with illustrations; "Flatworms," by F. W. Gamble; "Nemertines," by Miss L. Sheldon; "Thread-worms, &c.," by A. E. Shipley; "Rotifers," by Prof. Marcus M. Hartog; "Polychaet Worms," by Dr. W. Bloxland Benham; "Earthworms and Leeches," by F. E. Beddard, F.R.S.; "Gephyrea, &c.," by A. E. Shipley; "Polyzoa," by S. F. Harmer; "Round the Year: a Series of Short Nature Studies," by Prof. L. Miall, F.R.S., illustrated; "Sketches in Sport and Natural History," by the late Dr. George Kingsley, with a memoir by his son; "The Natural History of the Marketable Marine Fishes of the British Islands," prepared expressly for the use of those interested in the sea-fishing industries, by J. T. Cunningham, with a preface by Prof. E. Ray Lankester, F.R.S., illustrated; "Dictionary of Political Economy," edited by R. H. Inglis Palgrave, F.R.S., vol. ii., F.—M.; "Tree Worship," by Mrs. J. Henry Philpot, illustrated; "The Buddhist Praying Wheel and a Collection of Material bearing upon the Symbolism of the Wheel and Circular Movements in Custom and Religious Ritual," by William Simpson, illustrated; "A System of Gynæcology," by many writers, edited by Drs. Thomas Clifford Allbutt, F.R.S., and W. S. Playfair; "A System of Medicine," by many writers, edited by Dr. Thomas Clifford Allbutt, F.R.S., vol. ii., containing "Infections" (continued), "The Intoxications and the Parasites," also the general diseases of obscure causation, such as rheumatism, gout, diabetes, rickets, scurvy, &c.; "A History of Aryan Medicine," by H. H. the Thakore Saheb of Gondal; "Essays and Addresses by Sir J. Russell Reynolds," edited by Samuel Squire Sprigge; "A Text-Book of Botany," by Dr. E. Strasburger, Dr. Fritz Noll, Dr. H. Schenck, Dr. A. F. W. Schimper, translated from the German by Dr. H. C. Porter, revised and edited by A. C. Seward, with 594 illustrations, in part

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In the announcements of the Cambridge University Press we observe:—"The Collected Mathematical Papers of the late Prof. Arthur Cayley, F.R.S.," vol. xi.; "The Scientific Papers of John Couch Adams, F.R.S.," edited by Dr. William Grylls Adams, F.R.S., with a memoir by Dr. J. W. L. Glaisher, F.R.S., vol. i.; "The Foundations of Geometry," by the Hon. B. Russell; "A Treatise on Abel's Theorem," by H. F. Baker; "The Theory of Groups of a Finite Order," by Prof. W. S. Burnside, F.R.S.; "A Treatise on Universal Algebra, with some applications," by A. N. Whitehead.—Vol. i. contains the general principles of algebraic symbolism, the algebra of symbolic logic, the calculus of extension (*i.e.* the algebra of Graffmann's Ausdehnungslehre), with applications to projective geometry, to non-Euclidean geometry, and to mathematical physics; "A Treatise on Octonions: a development of Clifford's Bi-Quaternions," by Prof. Alexander McAulay; "A Treatise on Spherical Astronomy," by Sir Robert S. Ball, F.R.S.; "A Treatrise on Geometrical Optics," by R. A. Herman; "A Laboratory Note-book of Elementary Practical Physics," by L. R. Wilberforce and T. C. Fitzpatrick, parts ii. and iii. Cambridge Natural Science Manuals (Biological Series).—"Elementary Palæontology—Invertebrate," by H. Woods, second edition; "Fossil Plants: a Manual for Students of Botany and Geology," by A. C. Seward; "The Vertebrate Skeleton," by S. H. Reynolds; "A Manual and Dictionary of the Flowering Plants and Ferns: Morphology, Natural History and Classification, alphabetically arranged," by J. C. Willis, in two volumes; vol. i., outlines of the morphology, natural history, classification, geographical distribution and economic uses of the phanerogams and ferns; vol. ii, the classes, cohorts, orders, and chief genera of phanerogams and ferns, alphabetically arranged under their Latin names; glossarial index (to both volumes) of English names, economic products, technical terms, &c. Physical Series.—"Electricity and Magnetism," by R. T. Glazebrook, F.R.S.: "Sound," by J. W. Capstick. The Cambridge Geographical Series.—"A History of Ancient Geography," by the Rev. H. F. Tozer. "An Autobiography of George Biddell Airy, Astronomer Royal from 1836 to 1881," edited by Wilfrid Airy; "Chapters on the Aims and Practice of Teaching," edited by Dr. Frederic Spencer.

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Messrs. Osgood, McIlvaine, and Co.'s announcements include :—"Gorillas and Chimpanzees," by Prof. R. L. Garner, illustrated; "The Chronicles of a Virgin Fortress," being some unrecorded Chapters of Turkish and Bulgarian History, by William V. Herbert, with coloured maps; "On Snow-Shoes to the Barren Grounds: Twenty-eight Hundred Miles after Musk-Oxen and Wood-Bison," by Caspar Whitney, illustrated; "With the Jungle Folk: a Sketch of Burmese Village Life," by E. W. Cuming, illustrated by a native artist.

In Messrs. Hutchinson's announcements are to be found: "The Concise Knowledge Library: Natural History," by R. Lydekker, F.R.S., Dr. R. Bowdler Sharpe, W. F. Kirby, R. I. Pocock, W. Garstang, F. A. Bather, H. M. Bernard, B. B Woodward, and R. Kirkpatrick, illustrated; and "Astronomy," by Miss Agnes M. Clerke, J. Ellard Gore, and A. Fowler; "Hardy Coniferous Trees," by A. D. Webster, illustrated.

In Messrs. G. Bell and Son's announcements are to be found :—"Men and Women of the Century," by Rudolf Lehmann, edited by H. C. Marillier, illustrated; in the "Royal Navy Hand-books" Series—"Naval Ordnance and Small Arms," by Capt. H. Garbett, and "The British Fleet," by Commander C. N. Robinson, cheap edition; in the "Technological Hand-books" Series—"Coach-building," by John Philipson.

The autumn announcements of Messrs. W. and R. Chambers include :—"The Romance of Industry and Invention, comprising chapters on Iron and Steel, Big Guns, Evolution of the Cycle, Telegraph, &c.," edited by R. Cochrane; Dr. M'Kendrick's "Elementary Human Physiology"; Dr. Findlater's "Elementary Physiology," new edition, edited by D. Forsyth; three volumes of their "Elementary Science Readers."

Messrs. Baillière, Tindall, and Cox have almost ready :—"Applied Bacteriology," containing the latest methods of Research, by Messrs. Pearmain and Moor, illustrated; "Chemical Notes and Equations (Inorganic and Organic) for Students," by G. H. Gemmell; "Atlas of Practical Histology," by Prof. Arnold Brass, assisted by German Professors; authorised English translation by R. A. Young, illustrated.

Mr. J. C. Nimmo gives notice of :—"A History of British Birds," to which is added the author's Notes on their Classification and Geographical Distribution, by Henry Seebohm, in four volumes, illustrated (cheaper edition); "The Geographical Distribution of the Charadriidæ; or, the Plovers, Sandpipers, Snipes, and their Allies," by Henry Seebohm, in one volume, illustrated.

In Messrs. A. and C. Black's announcements we notice :—"A Dictionary of Birds," by Prof. Alfred Newton, F.R.S., part 4, or four parts in one volume; "Introduction to Structural Botany," by Dr. D. H. Scott, F.R.S., Part 2 (Flowerless Plants), illustrated; "Plea for a Simpler Life," by Dr. S. Keith, new edition.

Mr. Fisher Unwin calls attention to :—"Climbing Reminiscences of the Dolomites," by Leone Sinigaglia, translated by Miss Mary Alice Vialls, illustrated; "Rambles in Galloway," by Malcolm McL. Harper, illustrated; "On the Nile with a Camera," by Anthony Wilkin, illustrated.

Messrs. Seeley and Co., Ltd., will publish :—"The Life and Work of Charles Pritchard, D.D., F.R.S., late Savilian Professor of Astronomy in the University of Oxford," by his daughter, Ada Pritchard. A notice of his theological work by

the Right Reverend the Lord Bishop of Worcester, and an account of his astronomical work by his successor, Prof. H. H. Turner. With a portrait.

Mr. Heinemann's announcements include:—"Genius and Degeneration: a Study in Psychology," by Dr. William Hirsch, translated from the second edition of the German work, "The New Africa: a Journey up the Chobé and down the Okovango Rivers," by Dr. Aurel Schulz and Augustus Hammar; "Timbuctoo the Mysterious," by Felix Dubois, illustrated.

Mr. W. F. Clay, Edinburgh, announces:—"Select Methods in Quantitative Analysis," by the late Prof. W. B. Cheever, third and enlarged edition, by F. C. Smith; "Researches on Molecular Dissymmetry of Natural Organic Products," by Louis Pasteur, 1860; "Early Papers on Chlorine," by Scheele, Berthollet, Gay-Lussac, Thénard, &c. (Alembic Club Reprints); "Handbook of the Diseases of the Eye," by Douglas Watson.

Messrs. Lawrence and Bullen, Ltd., give notice of:—"The Kafirs of the Hindu-Kush," by Sir George Robertson, K.C.S.I., illustrated; "Turkish Fairy Tales and Folk-Tales," collected by Dr. Ignacz Kunos, translated from the Hungarian version by R. Nisbet Bain, illustrated; "The Encyclopædia of Sport," edited by the Earl of Suffolk and Berkshire, Hedley Peek, and F. G. Aflalo, illustrated. in twenty parts.

The following works will be issued by Messrs. Smith, Elder, and Co.:—"Prehistoric Man and Beast," by Rev. H. N. Hutchinson, illustrated; "A Course of Practical Histology," by Prof. E. A. Schäfer, F.R.S., new edition, illustrated; "A Practical Treatise on Traumatic Separation of the Epiphyses," by J. Poland.

Messrs. Gurney and Jackson have in the press: "Parasitic Diseases of Poultry," by Mr. F. V. Theobald, which, besides giving descriptions and illustrations of the various external and internal parasites affecting fowls, &c., will contain suggestions as to the best means for their destruction and for the cure of the diseases caused by them.

Messrs. Grevel and Co. announce:—"The Elements of Electro Chemistry treated experimentally," by Dr. R. Lüpke, translated by M. M. Pattison Muir, illustrated; "The Religion of the Ancient Egyptians," by Dr. A. Wiedemann, illustrated; "The Care of Children in Sickness and Health," by Father Kneipp.

Mr. Charles Carrington, Paris, announces "Untrodden Fields of Anthropology," observations on the esoteric manners and customs of semi-civilised peoples, being a record by a French army surgeon of thirty years' experience in Asia, Africa, and America, in two vols.

In the list of Messrs. Kegan Paul and Co., Ltd., we notice:—"The Polar Aurora," by Alfred Angot, translated (International Scientific Series); "In the Land of the Bora; or, Camp Life and Sport in Dalmatia and the Herzegovina," by "Snaffle," illustrated.

Messrs. W. Blackwood and Sons announce;—"From Batum to Baghdad, *viâ* Tiflis, Tabriz, and Persian Kurdistan," by Walter B. Harris, with illustrations and two maps; "The Story of Mr. H——, the Herbalist," by Hugh Miller.

Messrs. Hodder and Stoughton promise:—"Beginnings of Life in the Dawn of Geological Time," by Sir J. W. Dawson, F.R.S.; "The Land of the Monuments: Notes of Egyptian Travel," by J. Pollard.

In the list of Messrs. Cassell and Co., Ltd., we find:—"Charles Darwin and the Theory of Natural Selection," by Prof. E. B. Poulton, F.R.S.; "Social England," edited by Dr. H. D. Traill (sixth and concluding volume).

Messrs. F. Warne and Co. will issue:—"The Royal Natural History," edited by R. Lydekker, F.R.S., vol. vi., illustrated; "Favourite Flowers of Garden and Greenhouse," edited by E. Step, vol. i., illustrated.

Messrs. Ward, Lock, and Co., Limited, will publish:—"Coil and Current, and the Triumphs of Electricity," by Henry Frith and Stepney Rawson.

Messrs. Gay and Bird's books include:—"Building Construction and Superintendence," by Dr. A. E. Kidder, part i., Masons' Work, illustrated.

Messrs. Archibald Constable and Co. give notice of "The Popular Religion and Folk-Lore of Northern India," by Wm. Crooke, 2 vols., illustrated.

Messrs. W. H. Allen and Co., Ltd., will add to their "Naturalists' Library":—"Game Birds," vol. ii.; "Butterflies," vol. iii.; "British Birds," vol. iv.

Mr. L. Upcott Gill announces a work on "Fruit Culture," a section of which will deal with the life-histories of the insect and other pests which affect fruit-growers.

The list of Mr. David Douglas, Edinburgh, includes:—"Among British Birds in their Nesting Haunts," by Oswin A. J. Lee, illustrated, part i.

Messrs. Methuen announce:—Vol. ii. of Prof. Petrie's "History of Egypt, from the Earliest Times to the Present Day."

Messrs. Blackie and Son, Ltd., will publish:—"Fuel and Refractory Materials," by Prof. A. Humboldt Sexton.

Messrs. G. Philip and Son promise:—"Geographical Manual of Africa," and "Certificate Atlas of Africa."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Oxford.—Mr. Ernest Henry Stapleton, of the Grammar School, Bradford, has been elected to the Bristol Scholarship (thrown open *pro hac vice*) in chemistry and physics at St. John's College.

Cambridge.—Dr. W. H. Gaskell, F.R.S., has been appointed a member of the General Board of Studies. Mr. J. E. Gray, Scholar of King's, has been nominated to occupy the University's table at the Naples Zoological Station. Mr. James Henry Widdicombe, First Class Parts I. and II. Natural Sciences Tripos, 1891–92, has been elected to a Fellowship at Downing College.

Memorials signed by 2237 members of the Senate deprecating the admission of women to the membership or degrees of the University have been presented to the Vice-Chancellor. Of these 1369 would, however, approve the granting of some non-gremial title to women who pass a Tripos examination.

At the congregation on October 15, Mr. A. C. Dixon, of Trinity College, was admitted to the degree of Doctor in Science.

At the Massachusetts Institute of Technology, four associate professors have been promoted to full professorships: Mr. Dwight Porter, in hydraulic engineering; Mr. Alfred E. Burton, in topographical engineering; Mr. C F. Allen, in railroad engineering; and Mr. Peter Schwamb, in mechanism. New assistant professors are: Mr. George H. Barton, in geology Mr. George G. Robbins, in civil engineering: and Mr. Joseph J. Skinner, in mathematics.

At the recent opening of the collegiate year at Columbia University, 2100 students were enrolled, being the largest in the history of the College. Several gifts were announced, the most important being that of Mr. Charles C. Worthington, who, as a memorial to his father, the late Henry R. Worthington, will equip, with all necessary apparatus, a laboratory for the experimental study of the sciences of hydraulics and engineering as applied to hydraulics.

The following appointments have recently been announced: Dr. E. Wernicke to be professor of hygiene at Berlin; Dr. H. Stuhr has been appointed assistant in the Anatomical Institute at Breslau, in succession to Dr. Endres; Dr. Andreas Obrzut, of Prague, to the chair of Anatomy at Lemberg; Dr. Chermak to be professor of comparative anatomy and embryology at Dorpat; Dr. Winkler, Professor of Chemistry, to be director of the School of Mines at Freiberg i. S; Dr. Godschmidt to be assistant professor of chemistry in the University of Heidelberg.

Applications are invited for the Fellowship founded in 1894 by the Worshipful Company of Salters for the purpose of encouraging chemical research in the elucidation of pharmacological problems. The Fellowship is of the annual value of £100, and may be held for three consecutive years in the Pharmaceutical Society's laboratories. The regulations relating to the award may be obtained from the Clerk to the Company at Salters' Hall, but applications for the Fellowship must be sent to the Registrar of the Pharmaceutical Society before Saturday next, October 24.

Among the many evidences of the activity of the various Committees entrusted with the technical education of the country, one of the most pronounced is that afforded by the periodical reports which are issued by the different county authorities. In Essex the form assumed is that of *The Journal of the Essex Technical Laboratories*. In the twenty-second number, which

lies before us, we have, in addition to a brief recital of the most interesting local educational events, accounts of certain manurial trials which have been made in that county, and of experiments conducted at the Brightlingsea Marine Biological Station. The larger portion of the booklet, taken up with reviews, and notes on lessons in elementary chemistry, might be curtailed with advantage.

In opening a Technical and University Extension College, and a School of Science and Art, at Colchester on Tuesday, Lord Rosebery dwelt upon the urgent need of increased facilities for technical and commercial education in England. He remarked that Germany had long been twenty, thirty, or forty years ahead of us in technical education, and Switzerland was just as far advanced. Referring to the Germans, he said :—"They are an industrious nation ; they are, above all, a systematic nation ; they are a scientific nation, and whatever they take up, whether it be the arts of peace or the arts of war, they push them forward to the utmost possible perfection with that industry, that system, that science which is part of their character. Are we gaining upon the Germans? I believe, on the contrary, we are losing ground. The other day one of the greatest authorities on this subject went to Germany, being stirred up by what he had seen of alarm in the newspapers on the subject. He came back and told a friend of mine that he was absolutely appalled by the progress made in the last twenty years by the Germans in technical and commercial education as compared with what was going on in England. When I last spoke on this subject I made a modest proposal. It was, 'Cannot the Government order an inquiry to be made into the facts of this matter?' It would not cost as much as an ironclad. It would cost a very small sum indeed. I do not suppose it would cost a year's pay of the chief engineer of an ironclad. I believe it would be infinitely more useful. If necessary, three men like Lord Farrer, Sir Philip Magnus, and Sir Courtenay Boyle could without the slightest difficulty produce all the facts bearing on this subject without any expense whatever in the space of six months."

In acknowledging the vote of thanks for his address, Lord Rosebery gave further instances of the extraordinary vigour with which Germany is pursuing the work of technical education. The *Times* reports him to have said :—"At this moment the German Government are about to present a Bill to Parliament for the federalising, if I may so describe it, of all the skilled workmen of the country. Each craft of skilled craftsmen is to be formed into a guild, and each group of guilds is to be formed into a central committee. These central committees are, again, to elect chambers of handicrafts, on the model of chambers of commerce, to reside at the principal centres of industry. Side by side with this organisation is to be an organisation of apprentices, who will have their direct representatives on the central chamber. These organisations are to be formed under the direct supervision of the Government. They are to carry out measures designed to promote the moral and material welfare of workmen, to arrest strikes, to establish and assist the development of trade by inspection and supervision of the methods of training skilled labour. Technical schools are to be established and supported, and the whole system of technical instruction, already so perfect in our opinion, thoroughly overhauled. The Government Bill insists on the constant interposition of officials, mainly with the object of preventing the guilds from narrowing the recruiting ground, which they are now rather inclined to do. The main principle underlying the Bill is to create responsible bodies who should advise the Government what measures should be adopted to promote the interest of the skilled producer, and should carry out under Government supervision such measures as the Government on their advice should recommend. Now, I do not think that we like so much Government supervision as that in England. But I only call attention to the fact as showing how Germany, in spite of her start of us, and in spite of the apparent perfection of her methods, is still straining every nerve and every muscle to organise her skilled labour in such a way as to defy the competition of the world." We need only remark now that long ago we urged the formation of a responsible council to advise on matters affecting the progress of science and industry. Had such a council been instituted, our industries would have developed along with the increase of scientific knowledge. The nation will soon, perhaps, begin to realise what it has lost by neglecting scientific experience and advice.

SOCIETIES AND ACADEMIES.

Paris.

Academy of Sciences, October 12.—M. A. Chatin in the chair.—Elliptic elements of the Giacobini comet, by M. Perrotin.—On the extension of complete functions to an important problem in polynomials, by M. Émile Borel.—Cryoscopy of precision : reply to M. Raoult, by M. A. Ponsot. In the previous paper of M. Raoult, to which this is a reply, some remarks of M. Ponsot are severely criticised, and yet the substance of some of these remarks is adopted. In the present note the conclusion is drawn that there is now complete agreement as to the conditions theoretically necessary for obtaining the true freezing point of a solution ; but there are still some differences of opinion as to the best means of practically realising these conditions. The propositions put forward by M. Raoult in his last paper are criticised in detail.—Thermal studies on cyanamide, by M. Paul Lemoult. The cyanamide was prepared from thio-urea, and carefully purified from dicyandiamide. The molecular heat of combustion is 172 cal., and heat of formation 8·4 cal. ; the transformation into urea sets free 20·2 cal. The neutralisation with soda gave out 3·55 cal., but excess of soda gave rise to no further heat development.—Study of the sub-intestinal nervous system of the Orthoptera of the tribe *Mecopodinæ* (*Platyphyllum giganteum*), by M. L. Bordas. The great number of nervous centres, and the numerous branches of the sub-intestinal nervous system of *Platyphyllum giganteum* and allied species, show that this system must play an important part in the carrying on of the digestive processes. In this species there is a frontal ganglion, an œsophageal or hypocerebral ganglion, a pair of lateral œsophageal ganglia, and two intestinal ganglia, making six in all. The position of these, with their connecting nerves, is given in detail.

DIARY OF SOCIETIES.

THURSDAY, October 22.

South London Entomological and Natural History Society, at 8.—Discussion on Tephrosia biundularia and T. crepuscularia : C. G. Barrett.—Paper on the same subject : J. W. Tutt.

TUESDAY, October 27.

Royal Photographic Society, at 8.—Demonstration of Acetylené Apparatus for Portraiture and the Optical Lantern : C. Hoddle.

FRIDAY, October 30.

Physical Society, at 5.—Special Meeting, after which, at an Ordinary Meeting—A Satisfactory Method of measuring Electrolytic Conductivity by means of Continuous Currents : Prof. W. Stroud and J. B. Henderson.—A Telemetrical Sphe·ometer and Focometer : Prof. W. Stroud.—An Experimental Exhibition : R. Appleyard.

CONTENTS.

THURSDAY, OCTOBER 29, 1896.

SCIENTIFIC BIBLIOGRAPHY.

The Theory of National and International Bibliography. (With Special Reference to the Introduction of System in the Record of Modern Literature.) By Frank Campbell (of the Library, British Museum). Medium 8vo. Pp. 500. London: Library Bureau, 1896.

"WHAT is history," said Napoleon, "but a fiction agreed upon." . . . "The only point on which librarians are united is that classification is a question *disagreed upon*." So writes Mr. Campbell, and the quotation is an apt illustration of our present position. At a time, therefore, when the cataloguing and indexing of the literature of the mathematical and natural sciences is being so seriously taken in hand, and it is agreed that it shall be carried out by international co-operation, he is doing a considerable service by issuing in a collected form his various published papers on the theory of bibliography together with others not previously printed. Many of the suggestions made by him are undoubtedly of great value; it is a little unfortunate that his views are not presented in a more coherent, collected form, either at the commencement or end of the book, as it is not easy to extract the pith and marrow of his arguments, although it must be gratefully acknowledged that he has adopted the unusual course of trying, by means of darker type, to aid the eye as much as possible to discern the leading points in the several essays—thereby setting an example which it is worth while to carefully take note of.

The charm of the work is that it is characterised by breadth of view and the advocacy of a go-ahead-without-regard-to-obstacles policy, which give it a peculiar interest; indeed, it is delightful to find so much enthusiasm displayed over so dry a subject as the cataloguing of literature. But Mr. Campbell sees clearly the great importance of the problems to be solved, and that they must be dealt with on a corresponding scale, being evidently a determined supporter of the doctrine laid down by an authority so great as Carlyle ("You must front the difficulties, whatever they may be, of making proper catalogues") in the evidence he gave before the British Museum Commission of 1849, which is appropriately printed at the close of the volume. There can be no doubt that it is only by recognising the truth of this contention, *and carrying it into practice*, that scientific workers will be able in the future to fully secure from books the aid they can afford; it was freely admitted at our recent International Conference, and the fact that the meeting was dominated by such a spirit is the most hopeful omen of ultimate success that could possibly be desired.

"We are already half a century behind the times in bibliography, and are not moving fast enough," says Mr. Campbell; and he then asks, "Why this want of progress?" The reasons he gives, among others, are

"because we fail to recognise what an amount of theoretical and practical investigation of the subject is necessary before we can possibly be in a position to commence operations aright; because we continue to delude ourselves that it is possible for private enterprise to carry out that which the State alone can perform; and because we expect that Bibliography will evolve itself without a preliminary expenditure of money. We continue to build libraries and to accumulate books, but we have *not* paid sufficient attention to making books still more accessible for research. Our attention has been too exclusively concentrated on collections in particular libraries, to the neglect of the great annual national collection pouring from the press. Moreover, we have become too contentedly accustomed to the idea of confusion, and have grown to regard it as a natural and necessary evil. But it is high time to rise and shake ourselves free from the trammels of past traditions. We have roads and railways and rivers free of access to all. But the channels of *printed* thought communication are yet horribly blocked. It remains for us to clear them."

To all of which every one interested in the subject will say—Amen!

The book is very largely devoted to the discussion of matters of bibliographical reform. It was intended to issue it in time for the International Conference, and it would undoubtedly have been of interest to us. It is satisfactory that the circular letter issued by the Royal Society in 1894, in order to obtain opinions as to the feasibility of preparing a catalogue of scientific literature by international co-operation, is referred to by Mr. Campbell as remarkable as showing how thoroughly the Committee grasped the essential points of importance from a bibliographer's point of view. As we have been assured by over-anxious critics that we were on an altogether wrong track, such recognition is encouraging; and when the steps taken both during the preliminary stages and at the Conference are considered, it is clear that on the whole our action has been substantially in accord with the views set forth in detail in the work under notice, and will involve ultimately the putting into practice of many of its recommendations.

To readers of NATURE, one of the most important chapters in the book is that dealing with the influence and functions of learned societies in regard to bibliography, in which the much-needed and valuable advice is given that the learned societies should try to define their several jurisdictions more sharply, so as not to overlap, if it can be helped; and that they should pay greater attention to the details of publication. A large mass of literature appears every year—Mr. Campbell says—which, through the neglect of certain necessary principles and details, raises gratuitous obstacles in the path of research, and defies the best efforts of librarians to remedy the evil. . . . Learned societies are among the worst offenders in the matter, he asserts. . . . But in the majority of instances, he thinks, it is rather a matter of ignorance, or oversight. There has not been sufficient scientific study of the subject, and men have not yet realised the full necessity for absolute co-operation between the author, printer, publisher and librarian.

Those of us who have to do with the publication of accounts of scientific work are only too well aware that such is the case. There is no doubt that learned societies allow far too much freedom of individual action, and that while taking objection to technical points—the responsibility for which might well be cast entirely upon authors—allow the gravest literary malpractices to pass unnoticed. Writers in scientific periodicals are too often either inexperienced or careless owing to want of leisure,

and consequently offer papers which are ill-arranged and intolerably diffuse, being full of unnecessary detail. I would have all such returned to their authors, although I well know, from sad experience, that nothing gives greater offence. But what a reformation of our scientific literature will follow from the adoption of such a course! We shall then be able to read what is written. Carefully composed and provided with well-chosen titles, our papers will be easy to index; and when memoirs are kept within reasonable compass, library shelves will not be so grievously overburdened with waste-paper as they are under the present want of system.

"The writing out of scientific investigations is usually a troublesome affair; at any rate, it has been so to me. Many parts of my memoirs I have re-written five or six times, and have changed the order about until I was fairly satisfied. But the author has a great advantage in such a careful wording of his work. It compels him to make the severest criticism of each sentence and each conclusion. . . . I have never considered an investigation finished until it was formulated in writing, completely and without any logical deficiencies. Those among my friends who were most conversant with the matter represented to my mind my conscience, as it were. I asked myself whether they would approve of it. They hovered before me as the embodiment of the scientific spirit of an ideal humanity, and furnished me with a standard" (H. v. Helmholtz, Jubilee Address).

May we not say—"Scientific societies, please copy"? No one could take offence if such a quotation were printed at the head of the circular letter requesting an author to revise his manuscript.

To reproduce almost verbally the voluminous notes of a piece of work made from day to day in the laboratory book serves the purpose neither of the writer nor of science, as the results become obscured in a mass of unnecessary detail. And we rarely need to know the process of self-education through which the worker passes. In this matter also we may therefore, as a rule, safely take Helmholtz as our guide, and follow the advice he gives by implication when he says: "In my memoirs I have, of course, not given the reader an account of my wanderings, but I have described the beaten path on which he can now reach the summit without trouble."

Mr. Campbell has much to say on the value of the section in the arrangement of a work which may be commended to scientific writers. All must agree with him that the future of literary study is greatly dependent on special libraries or sections of libraries in which *all* the works on particular subject-groups are to be found; and that, instead of following the principle of first making a muddle and then indexing it, scholars of particular subjects will demand that their material shall be kept separate from other literature. The argument applies equally to individual papers, if these are to be properly indexed in the future; and in principle it is the argument which leads us to insist that carefully classified subject-indexes must be regularly supplied for the use of workers in science.

"One thing is very certain, that people *will* have special bibliographies, whatever we may say, because they supply a legitimate want. We may, therefore, just as well seriously take the matter in hand and see that it is done properly once and for ever, instead of allowing it to be done badly. And on this head be it remembered that the curse of bad work does not always end with itself, but often not only delays but actually prohibits the work from ever being properly carried out."

Sounder advice could not possibly be given, and it is refreshing to find the opinion expressed by Mr. Campbell that it is a fallacy to suppose that bibliographers can never agree together on any one system of classification; one of the most deadly arguments brought against the idea of special bibliographies, it is one, he says, which he trusts we shall soon trample under foot. And it is important to note that he is not considering books alone: any article on a subject is defined by him as a work to be catalogued and indexed.

Mr. Campbell regards State aid as essential in the preparation of national bibliographies, and his proposals on this head are worthy of the most serious attention; it is more than probable, now that the work of organisation is being put in hand, that effective steps may soon be taken to secure the registration of State publications for which he pleads. One of the most important resolutions adopted at the International Conference had reference to the organisation of national offices in connection with the international central office.

Once set rolling, the ball cannot possibly be brought to rest. The appearance of so many distinguished and representative delegates at the meeting at the Royal Society's rooms—and the complete unanimity which prevailed on all essential questions—was evidence of the general willingness to recognise the importance of the scheme; the vote taken at the outset was a formal ratification of its purpose, and will serve to pledge the various Governments concerned to do their utmost to facilitate the execution of the enterprise. There can be little doubt that scientific bodies generally must now regard it as their duty to promote such a work: those who do not will be guilty of shameful desertion in the face of the enemy, for never was such an opportunity given before.

But the Conference clearly recognised that the individual worker must also take an important share in the work, as in preparing the subject-matter index regard is to be had not only to the title of a paper or book, but also to the nature of the contents. It will be necessary therefore, in the future, that all publishing bodies insist that authors supply subject-indexes with their papers, as the work of reading papers with this object in view cannot possibly be carried out at any central office. The preparation of such subject-indexes will, however, need the greatest care, in order that whilst all points are indicated to which the attention of workers should be drawn, at the same time the entries are, as far as possible, limited in number.

It is to be hoped that serious attention will now be given to the question of indexing, and that the requirements to be met will be fully realised. As Mr. Campbell very properly insists, a large amount of theoretical and practical investigation of the subject is necessary before we can possibly be in a position to commence operations aright and develop a scientific bibliography of the literature of science. How to classify the subject-matter in the various main and sub-branches of science is the great question before us, which needs an immediate answer, and to which we must therefore most earnestly devote our attention.

HENRY E. ARMSTRONG.

PALÆONTOLOGY AND EVOLUTION.

Essai de Paléontologie Philosophique: Ouvrage faisant suite aux Enchaînements du Monde Animal dans les Temps Géologiques. By Prof. Albert Gaudry. Pp. 230. Paris: Masson et Cie, 1896.

THE present volume forms a supplement to Prof. Gaudry's well-known series of semi-popular treatises on Palæontology, entitled "Enchaînements du Monde Animal dans les Temps Géologiques." In it the author has summed up most of the evidence brought forward in his previous volumes, and attempts to deduce from it a general outline of the course of the evolution of the animal kingdom from the dawn of life to the present day. Like so many French scientific writers, Prof. Gaudry possesses in an eminent degree the power of presenting the facts of his science to the general reader in a lucid and attractive manner: in this respect the book leaves nothing to be desired. If however, its arguments be examined, there is less cause for satisfaction, many of them being illogical, and giving evidence of strong bias on the part of the author. Moreover, the neglect of much of the recent literature of the subjects discussed is greatly to be regretted.

The dominant idea of the book is, that there is a general parallelism between the evolution of animals in the course of geological time and the development of an individual man in the course of his life, there being in both cases a gradual increase in the number of the constituent elements, and in the degree of their differentiation, as well as in bulk, activity, and intelligence. That such an analogy is to some extent traceable, probably no one will be disposed to deny, but the writer attempts to push it too far.

Thus two plates of restored figures of various living and extinct animals, drawn to scale, are given for the purpose of demonstrating that there has been a gradual increase in bulk from the first. Now it may be quite true that some of the whales are the largest animals that have ever existed; but if we examine any of the great groups, other than the mammals, which are of comparatively recent origin, it becomes clear that no such progressive increase in bulk has taken place. In most cases there has been an increase up to a certain point; but this has been followed by a diminution. For example, the Amphibia attained their maximum size in the Triassic, the Reptilia in the Jurassic periods. Even the Mammalia seem to be already on the decline in point of size, the Pleistocene species having, in most cases, been larger than their modern representatives. The whales, owing to the peculiar conditions of their existence, are exceptional, but they also are probably doomed to extinction at no very remote date.

As to the causes of evolution, Prof. Gaudry dismisses Lamarck and Darwin in two lines, with the remark that the question is at present too obscure for discussion. He then proceeds to discuss it at considerable length, and arrives at results so remarkably simple, that the reason for his unceremonious treatment of other writers becomes apparent. In short, Prof. Gaudry considers that organic evolution is directed from the outside by a conscious agent, and that while sublunary causes may be held accountable for the loss or reduction of any existing organ, the appearance of any new structure is attributable to the direct interposition of this guiding power. That such views should find expression in a work by so eminent a writer, and particularly in one intended for the general reader, is much to be regretted, since they are certain to lead to much misconception as to the present position of the doctrine of evolution; while they will be triumphantly quoted as authoritative by those with whose preconceived ideas they seem to harmonise.

The book is well printed and illustrated, and is a storehouse of interesting facts, but is not to be recommended to those who do not possess the necessary knowledge to separate the wheat from the tares.

GATTERMANN'S PRACTICAL ORGANIC CHEMISTRY.

Practical Methods of Organic Chemistry. By Ludwig Gattermann, Ph.D. Translated by William B. Shober, Ph.D. Pp. 329, with 82 Figures. (London: Macmillan and Co., Ltd., 1896.)

FOR some time past the student of organic chemistry has been amply provided with text-books and manuals dealing with the theory and facts of the science, but even now his choice is very limited when he comes to select a book which will help him to overcome difficulties in the laboratory.

For this reason alone the appearance of Prof. Gattermann's work in German was warmly welcomed in this country, not only by students, but also by those who have to direct practical work in organic chemistry; and the translation, which has now been made by Dr. Shober, and which "is intended for those students of chemistry who have not yet become sufficiently familiar with scientific German to be able to read it accurately without constant reference to a dictionary," will no doubt make the work accessible to an even larger number of readers.

The book is divided into three parts, the first of which deals with crystallisation, distillation, and other methods of purification, and also with the analytical methods employed in the case of organic compounds. In this part the author describes in great detail most of the operations which have to be constantly performed in preparation- and in research-work, and also the apparatus which is generally employed.

It is evident that the greatest care has been taken to make this description so complete that it would be hardly possible, even for a beginner, to make mistakes in his later work, if he had thoroughly mastered this introductory, but very important, part. In adopting such a plan a certain amount of repetition is perhaps unavoidable, and in some cases instructions which have been given only a page or two previously, are repeated almost word for word. It is no doubt with the same object, namely, of preventing accidents and mistakes, that the author has in a few instances given directions which appear to be quite unnecessary, and which seem to imply that the student is devoid of common sense.

The description of the ordinary analytical methods, which closes Part i., is so minute in every particular that an ordinary combustion, for example, should be carried out successfully by a beginner without further assistance; some portions here might, perhaps, be abridged with

advantage, especially those dealing with the estimation of halogen and of sulphur, but merely in order that space might be found for a description of the analysis of organic salts, &c., and of the methods used in the determination of vapour density and molecular weight; such an alteration would make this general part even more useful as an introduction to research-work.

In Part ii. the author gives instructions for the preparation of a large number of compounds, the examples being carefully chosen in order to illustrate practically all the more important reactions, including those only recently discovered. After each preparation there follows a brief account of the theory of the reaction which has been studied, other practical methods by which similar results may be attained are pointed out, and, with the aid of numerous examples, the general application of the reaction is considered; the properties of the preparation, and of the class of substances to which it belongs, are also described, the more important reactions being illustrated by test-tube experiments which the student is directed to perform. The classification of the preparations into "alipathic" and "aromatic," which is here adopted, and the treatment of the former before the latter, are no doubt necessary from an author's point of view; but if this course is strictly adhered to in practice, it has the disadvantage that the student undertakes some of the more difficult preparations before he has had any experience. Prof. Gattermann does not indicate whether the preparations are intended to be carried out in the given order; but as each is practically complete in itself, there is no reason why a little discretion should not be exercised, the easier ones being taken first.

This part of the book is an elegant combination of practice and theory, and cannot fail to arouse and maintain interest in both; it will doubtless have the result which the author desires, namely, "that the student already, during the period given to aboratory work, becomes familiar with the most varied theoretical knowledge possible, which, acquired under these conditions, adheres more firmly, as is well known, than if that knowledge were obtained exclusively from a purely theoretical book."[1]

In Part iii., which consists of a few pages only, the author gives details of the preparation of some inorganic compounds (the halogen acids, phosphorus chlorides, &c.) which are very frequently used in organic work.

It would be hard, indeed, to express anything but a very favourable opinion of Prof. Gattermann's excellent book as an introduction to practical organic chemistry; a student who reads it carefully will save himself labour, time, and material, and will avoid many of the usual mistakes and accidents; at the same time, he will gain a sound practical knowledge which will help him to commence research with a good prospect of success.

Dr. Shober's translation is very readable, although it bears traces of the impress "Made in Germany": the nomenclature might, perhaps, have been brought more in accordance with that adopted by the Chemical Society, but inasmuch as almost every chemist has his own system, it is impossible to please all.

Since the advance of organic chemistry in this country must, in some measure, depend on the nature of the available text-books, both the author and translator deserve our thanks for providing us with a work such as the present one. F. S. K.

[1] Author's preface.

OUR BOOK SHELF.

The Detection and Measurement of Inflammable Gas and Vapour in the Air. By F. Clowes, D.Sc., and Boverton Redwood, F.R.S.E. Pp. xii + 206. (London: Crosby Lockwood and Son, 1896.)

THIS book describes the evolution of the "hydrogen-lamp" for the detection and estimation of fire-damp in coal-mines, as well as for the detection of other gases and vapours which may form explosive mixtures with air. In an historical introduction, and in various appendices, Prof. Clowes gives an account of the various appliances which have been brought forward for the detection of small quantities of fire-damp, and each method in turn is criticised and condemned in view of the "superior advantages" of the hydrogen-lamp. How far it is desirable for the inventor of a particular process to write a book on the general subject of gas-testing, and to criticise rival inventions in it, need not be discussed; the literary character of the book certainly suffers, as witness the following:—"The advantages of the hydrogen-flame render it so distinctly superior to every other testing-flame, that those who have once become familiar with its use prefer it to all other flames in delicate and accurate testing." This is not taken from a page of advertisements, but is the last paragraph of the "historical summary."

Apart from this one fault we have no criticism to make. Prof. Clowes has put together in a convenient form a number of bits of information useful to mining engineers, and has given full details of his own experiments on a difficult and important subject. The success of the hydrogen-lamp has passed beyond the experimental stage. It is a practical instrument, which we feel confident will lead to increased safety in mining industry. Prof. Clowes shows how the lamp can be used for detecting other inflammable gases, as well as for showing the presence of carbonic acid in the air; and Mr. Boverton Redwood contributes a chapter on its use in detecting inflammable vapour from petroleum. The construction of petroleum-tank steamships has made an accurate test for petroleum vapour necessary, and the hydrogen-lamp of Prof. Clowes has been successfully adapted for this purpose. The book is capitally illustrated.

Mensuration. By Alfred Lodge, M.A. Pp. 274. (London: Longmans, Green, and Co., 1895.)

IN this book the student is assumed to have an elementary knowledge of mensuration, and to know, also, something of elementary trigonometry as far as the solution of triangles; in fact, it is intended chiefly for senior students. In its arrangement, volumes, surfaces, and solids are first dealt with; then follow chapters on spherical lunes, triangles, polygons, regular polyhedra, and plane figures. An interesting chapter is given on the mensuration of such earthworks as would be required in excavating cuttings for roads or railways, and in the construction of embankments. Chapter viii. is confined chiefly to the use of logarithms in solving triangles, while the following one is devoted to the relationship between British and metric measures. A short survey shows that the book should prove serviceable to those readers who wish to acquire a sound knowledge of the theoretical side of this subject. It may be mentioned that in the determination of volumes of solids the formulæ are, for the most part, all based on Simpson's rule. A great number of both numerical and algebraical examples are scattered throughout, and very neat and instructive figures are inserted in the text.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Measurements of Crabs.

ON June 11 last, a paper by Mr. Herbert Thomson was communicated to the Royal Society, "On certain changes observed in the dimensions of parts of the carapace of *Carcinus mænas*" (*Proc. Roy. Soc.*, lx. No. 361). According to measurements recorded in this paper, the male crabs taken at Plymouth in the year 1895 were narrower in the frontal breadth, and longer in the right dentary margin than male crabs of the same size taken in 1893.

The author of the paper states that further measurements will be necessary in order to decide whether these results indicate a permanent change in the species at Plymouth, or a mere oscillation, such as may be constantly going on in the relative dimensions of parts in a species.

I venture to remark that species must be much more unstable than we have ever supposed hitherto, if either permanent changes or mere oscillations in their characters are to be detected in one locality in the course of a couple of years. There is one other possible explanation of the observed differences which has occurred to my mind, and is, I think, worth consideration on the part of those who are studying evolution by means of the micrometer. It appears from the paper that the measurements of the 1893 crabs and of the 1895 crabs were made, not in those years respectively, but both sets alike after the summer of 1895. The two sets of crabs were, in this case, not measured under identical conditions. If the 1893 set had been longer in spirit than those of 1895, perhaps this was the reason of the difference. Or there may have been some difference in the mode of preservation. At any rate, I think the comparison is not trustworthy unless the measurements had been made on fresh crabs immediately after they were collected—one set in 1893, the other set in 1895. It is doubtful whether measurements of spirit specimens are ever perfectly trustworthy as representing the true dimensions of animals.

The fact that a deficiency in one dimension was "compensated," as the author himself expresses it, by an excess in the other, suggests the question whether the specimen of one lot or the other had not undergone an artificial change of shape. It seems to me that that question must be disposed of before we admit that a permanent or temporary change in the specific dimensions of parts in the crab has been demonstrated.

J. T. CUNNINGHAM.

Some Effects of the X-Rays on the Hands.

AT the request of the editor of NATURE, I append the following description, compiled from notes, of the effect of repeated exposure of the hands to the X-rays. The result, though perhaps interesting from a medical and scientific point of view, has been most unpleasant and inconvenient to myself—the patient—and although my theories may be incorrect, and my conclusions easy to demolish, there is no mistaking the fact that the X-rays are quite capable of inflicting such injury upon the hands as to render them almost useless for a time, and to leave in doubt their ultimate condition when entirely freed from frequent daily exposure to their influence.

Now for facts. I commenced demonstrating early in May with a coil capable of giving an 8" spark, and have been engaged in the work for several hours per day until the present time. For the first two or three weeks no inconvenience or discomfort were felt, but there shortly appeared on my right-hand fingers numerous little blisters of a dark colour under the skin. These gradually became very irritating, the skin itself very red and apparently much inflamed. The irritation increased, and the application of *aqua-plumbi*, as recommended in a Berlin telegram to the *Standard*, had only a passing effect in allaying it. So badly did my hand smart, that I was constantly obliged to bathe it in the coldest water I could get, and I really believe I should have been obliged to resign my appointment had not a well-known medical man, who happened to attend one of the demonstrations, advised me to use a much-advertised ointment. I did so, with the remarkable result that the irritation left me immediately, and by using it regularly since then, I have at least avoided one of the disagreeable consequences of too much X-rays. In the meantime, however, the skin on the fingers had become very dry and hard, yellow like parchment, and quite insensible to touch, and I was not at all surprised to find, a day or two afterwards, that it began to peel off. When this particularly unpleasant operation had been accomplished, I considered I was quite acclimatised to the rays, but soon found out my mistake. The same symptoms again appeared, the newly-formed skin going the same way as in the former case. But there was a further discomfort to follow. About the middle of July the tips of my fingers began to swell considerably, and appeared as if they would burst. The tension of the skin was very great, and, to crown all, I noticed for the first time that my nails were beginning to be affected. This was the commencement of a long period of really serious discomfort and pain, which was only partly relieved when, from under the nails, there appeared a somewhat copious and unpleasant-smelling colourless discharge, which continued more or less until the old nails were thrown off. With this discharge the swelling in the finger-tips decreased, but as the new and old nails began to separate in the middle, the pain was renewed, and I was unable to bear the slightest pressure upon them. The old nails turned quite black and very hard, and the state of my hands may be imagined when I say that I had to keep the fingers in bandages for more than six weeks. It was only in the middle of August that my left hand became affected by the rays, as until then I had principally used my right hand in the manipulation of the fluorescent screen. I naturally expected to again undergo the same experience, with all its discomforts. I had lost the skin of my right hand for the third time, and there seemed to be no probability of that being the last. Several doctors had seen my hands, and taken much interest in their condition, but no one could suggest a remedy.

At last it occurred to me that all the trouble was being caused by the rays burning out the natural oil of the skin, and that if I could in some way supply the deficiency, it might assist in preventing further ill effects. For that purpose I got some lanoline, the oil obtained, so I am informed, from sheep's wool. This I daily rubbed into my hands, and then encased them in a pair of ordinary kid gloves. These gloves, in the course of time, became saturated with the ointment, and there is no doubt that, although in themselves they were quite transparent to the X-rays, and therefore no shield in themselves, the fatty matter did, in a great degree, prevent the drying up of the skin in the manner I have described. I do not mean to say that it is an absolute preventive, but it goes a long way towards that desirable end, because since I first used the lanoline, now some weeks since, my hands have not again peeled, although at the present moment (October 17) there are a few slight symptoms of it.

My view of the effect of the X-rays is that, in regard to this matter, it is exactly similar to acute sunburn. The symptoms and effect are the same, only that, in the case of the X-rays, you have it in a far more concentrated form—in fact the very essence of it. But whatever may be the cause, the effect is unquestionable. In my case I have had three new sets of skin on the right hand, and one on the left; four of my finger-nails have disappeared on the right, two on the left, and three more are on the point of leaving. For at least six weeks I was unable to use my right-hand fingers in any way whatever, and it is only since the nails came off that I have been able to hold a pen. Of course it will be a month or two before my hands resume their natural condition, and it is yet, as I said before, a moot point as to what the end will be.

I could say much more on this subject, but already I fear I have trespassed too much on the editor's space. I have written this with the object of placing upon record "the strange case of an X-rays operator," in the hope that it may add something to what is known of the new and mysterious power, and lead others, more experienced in scientific and medical knowledge than myself, to devise an effectual preventive against such results as I have described. Many important questions are opened up by this remarkable effect of the rays upon the skin and nails, and it may be that in the near future they may be utilised in cases of skin and other diseases. Who knows? S. J. R.

X-Rays Syndicate, Indian Exhibition, Earl's Court, London.

Habits of Chameleons.

I HAVE just read Mr. Ridsdale's letter about the Chameleon, and write to say that I have one here which has lived in England since May 23, 1891, when it was brought from the Cape by my

nephew. I imagine it must be somewhat different to Mr. Ridsdale's specimen, judging from the variations of colour. This one has green as its predominant colour, changing in a bright light to a brown or almost chocolate hue, and at night it is often a bright canary yellow, especially when kept, as it was on its first arrival, in a cage which was painted cream colour inside. Only once have I seen it turn white, and that was when I was just in time to save it from being killed by a cat, and then I suppose it was the result of fear. It frequently has yellowish stripes running along its body, and sometimes round red spots. Not unfrequently one side of its body is of a different colour to the other. It drinks only sparingly, but I saw it do so this morning, putting its head right into the glass with which it is supplied.

After it had been in England about a year it surprised us by laying some eggs, and has done so again within the last few months. The eggs are roundish, about the size of small peas, and of a clear orange colour, somewhat resembling grains of maize. If either Mr. Ridsdale or Mr. Bartlett would like to have one, I should be pleased to send them specimens.

The last time it changed its skin it had the misfortune to lose about half an inch of its tail, from what cause I am unable to say, and this has made it much less able to get about, as the loss deprived it of the little hook at the end of the tail with which it used to cling to the sticks on which it climbs. I never saw it try to help the skin off with its feet, and it has generally come off in flakes, taking a fortnight or so over it.

I think the most extraordinary thing about the reptile is the wonderful way in which the two eyes work quite independently of each other, and enable it to survey comfortably objects in quite opposite directions. A. ALEX. BLAKISTON.

Glastonbury, October 21.

Chameleons at the Zoological Society's Gardens.

MR. RIDSDALE must have mistaken Mr. Bartlett when he states (NATURE, October 15) that there are no Chameleons in the Zoological Society's Gardens. We are seldom, if ever, without examples of these reptiles, and at the present moment have five specimens, three of *Chameleo vulgaris* from North Africa, and two of *Chameleo pumilus* from the Cape. At various times we have exhibited specimens of eight species of Chameleonidæ. I may add that Chameleons generally do not do well in captivity, and require constant attention. P. L. SCLATER.

3 Hanover Square, London, W., October 22.

The Organisation of Technical Literature.

THE "Catalogue of Scientific Papers," compiled and published by the Royal Society of London, was intended to serve as an index to the titles and dates of scientific papers contained in the Transactions of societies, journals, and other periodical works. This Catalogue is highly valuable to all technical inquirers, and it is a matter of deep regret that the International Conference, held under the auspices of the Royal Society of London, has decided that the International Catalogue of Scientific Literature, which is to begin with 1900, is to relate to pure science only, applied science being strictly excluded. It is possibly too late to remedy the position, which is probably due to the absence of representatives of technical societies at the International Conference.

It would seem desirable, further, that there should be a conference of technical societies to discuss the publication of a subject-matter index to technical and scientific periodicals. The Federated Institution of mining engineers has had for some time before it the question of the publication of such an index of subjects of interest to mining and metallurgical engineers; and probably a comprehensive index to engineering and other technical papers would prove more valuable.

This suggested conference of technical societies might also consider other questions which interest technical societies individually, but which they are unable to obtain owing to want of concerted action. Thus, such an association might approach the Government on such questions as the excessive cost of postage of Transactions, as there can be no valid reason why they should not be placed in the same position—although their Transactions are issued at varying intervals of time—by a short Act of Parliament, as an ordinary weekly newspaper.

And there are many other matters, which no doubt crop up in connection with the carrying out of the objects of individual societies, in which concerted action would produce valuable results. M. WALTON BROWN, *Secretary*.

Neville Hall, Newcastle-upon-Tyne, October 21.

A Mechanical Problem.

A MAN stands in a box, whose sides, floor, and top are rigid and inelastic, the box itself being light as compared with the weight of the man, and a few inches higher than himself. The man jumps, and strikes the roof with his hands or head.

Is it possible for him to raise the box in this way (even in a small degree) perpendicularly from the ground? "CROMERITE."

[(1) The box rests on the ground. Therefore the downward push of the man on the box on springing is balanced, and no more affects the motion of the box than if his feet rested on the ground. If his muscular force were great enough, he could give infinite velocity to his body. He is now moving, the box still at rest as before. When his head strikes the top, the rate of destruction of his upward momentum is the upward force on the box, and this depends on the elasticity of his head. If his head is rigid enough he lifts the box, however heavy it may be.

(2) The "argument waged round" the question is possibly based on the idea that the box and man are in free space. In free space, nothing that the man can do will affect the motion of the centre of mass of the whole system (the box-man system); but the box itself moves, so that even in free space "the man moves the box."—J. P.]

Extension of the Visible Spectrum.

WHILE engaged on work in connection with the discharge of electrification by ultra-violet light, we have come across a fact which it may be convenient to state by itself, viz. that the spectrum of an arc can be made visible over the greater part of its immense range of action on electrified metals, by receiving it upon a screen of the double fluoride of uranium and ammonium, such as is frequently used for displaying X-rays. The arc-light must, of course, be passed through a quartz train, and a long arc is best, especially an arc containing aluminium; but under these circumstances, whereas the ordinary visible spectrum may be three-quarters of an inch broad, a breadth which may be doubled or trebled by the use of ordinary fluorescent substances, the spectrum received upon a uranium screen is five inches broad, and is full of bright lines.

Suitable screens are supplied by Ducretet of Paris, or by Chadwick of Manchester, or they can be readily made; and any one possessing either a Rowland grating, or a quarter prism and lens, can try the experiment.

It is just possible that it has not been noticed, to the full extent, before. OLIVER J. LODGE. BENJAMIN DAVIES.

Liverpool, October 26.

ON THE COMMUNICATION OF ELECTRICITY FROM ELECTRIFIED STEAM TO AIR.[1]

THE experiment described in this paper was a first slight instalment of an investigation, which we have proposed to make, of the diffusion of electricity through air, and the communication of electricity from the molecules of one gas to the molecules of another beside it or mixed with it.

By arrangements, readily imagined, we electrified dry superheated steam at atmospheric pressure by a needle-point connected with an electric machine. The dry electrified steam was drawn off through a tube with an inlet admitting unelectrified air to mix with the steam. The mixed air and steam were drawn off through the metal worm of a still, and cooled by an abundance of cold water around the worm. The condensed water fell into a Wolff's bottle, in one neck of which the exit tube of the worm was fixed. The air, thus cooled and partially dried, was drawn out of the other neck of the Wolff's bottle through a drying tube of pumice and sulphuric acid; and thence through a short paraffin tunnel to one of our electric filters,[2] insulated and connected with the

[1] Abstract of communication to Section A of the British Association at Liverpool (September 21), by Lord Kelvin, G.C.V.O., F.R.S., Magnus Maclean, and Alexander Galt.

[2] "On the Diselectrification of Air," *Proc. R.S.*, March 1875.

insulated electrode of a quadrant electrometer. Through a second paraffin tunnel, at the other end of the filter, and a connecting pipe, the air is drawn off by an air-pump. All the metal of the apparatus, except the filter, and except the electrometer-vane, is connected with the metal case of the electrometer.

We were much interested to find, as we expected, that the steam gave up a large part of its electricity to be carried away by the air, while it itself was left behind in the Wolff's bottle and the sulphuric pumice. We tried the experiment both with positive and negative electrification, and found it equally successful in the two cases.

A full description of the experiment, with drawings representing the apparatus, is given in a paper, on the electrification of air and other gases, which we hope to communicate to the Royal Society at its first meeting in November.

THE NOVEMBER METEORS.

As the lapse of time brings us nearer to the maximum of these phenomena, the interest in this branch of astronomy is intensified, and our liveliest expectations encouraged. These meteors only return in their richest abundance once in thirty-three years, so that the spectacle they afford can only be witnessed once in a generation. It is true that the shower may be manifested in a pretty conspicuous manner in several successive years, but only one really brilliant exhibition is usually seen, as on the mornings of November 13, 1799, and 1833, and November 14, 1866. Two years before the maximum and three years after it, striking displays have occurred, and show that the orbit of the meteors is very thickly strewn with these bodies over a considerable arc, since it takes six years for them to cross the earth's track, though travelling at the rate of about twenty-six miles per second.

Every one who has watched a great meteoric display, will admit that there is no other celestial spectacle which can compare with the striking aspect it presents. Those who have seen an event of this kind often recall its vivid characters, and look forward to the prospect of re-observing it. Others who have never witnessed it have heard or read the descriptions of people who have been more fortunate, and are anxious to behold so impressive and wonderful a phenomenon. Apart from being an attractive sight to the popular eye, it is a most important event from a scientific point of view, and the regular recurrence of this fine shower has been the means of largely augmenting our knowledge of meteoric astronomy.

The all-important question now is, "Will the display be repeated this year in an imposing form, and merit close attention from the casual observer as well as the professional astronomer?" A definite answer can scarcely be given, for our knowledge of this particular system of meteors is not sufficiently extensive to enable us to speak with certainty. Changes are doubtless affecting the stream, and the effects are cumulative; thus the circumstances attending the ensuing return will be somewhat different to those which controlled those of 1833 and 1866. The meteors are probably lengthening out along the orbit owing to the differences in periodic time amongst them, and the stream is widening as an effect of planetary perturbation. Thus in future ages the shower will probably return in many consecutive years near the epoch of maximum, while the maximum itself will be less brilliant than in former times, unless, indeed, on an occasion when the earth crosses the meteor orbit at a point very near the parent comet of Tempel (1866 I.) forming "the gem of the ring." The shower will probably last for several weeks in a feeble character, owing to the disturbances set up by the earth during its frequent immersions in the stream. The latter must evidently be undergoing a gradual process of thinning out, since our atmosphere destroys by combustion such of the particles as enter into it, and the number so destroyed must amount to many millions whenever a rich shower occurs. Still, in comparison with the enormous number of meteors comprised in the whole system, the proportion caught and vapourised by the earth must be extremely insignificant. After a long series of years the Leonid display, like that from Perseus in August, will probably become a pretty rich annual shower, and lose much of the grandeur which has attended it at intervals of about thirty-three years in the past.

From various observations obtained in November 1895, there was no sign of development in the Leonid meteor shower. The number seen did not exceed those counted in 1879 and 1888, when we were much further removed from the maximum. On the morning of November 14, not more than five Leonids per hour were counted at any station in England, and the display was therefore of very ordinary character. If, however, it failed as regards numbers, it exceeded expectation in respect to duration, for on the morning of November 17, Mr. Corder saw twelve Leonids out of twenty-two meteors counted in the two hours between 4h. 15m. and 6h. 15m. a.m., and on November 18, he observed eight Leonids out of thirty meteors seen in three hours between 2h. and 5h. a.m. Next month there is a far greater probability that we shall see a display at least much above the average, as we are twelve months nearer the maximum epoch, and this should make all the difference. But as we cannot expect the richest exhibition until 1899, we are still three years in advance of the important time, and are scarcely justified, from the prevailing conditions, in anticipating a brilliant revival of the shower this year. Conspicuous displays occurred in 1831 and 1864, two years before maxima, and in 1897 the shower is likely to develop considerable strength, increasing in 1898, and culminating in 1899. In 1863, three years prior to the magnificent return of 1866, not a great number of meteors were seen, but there is evidence that the Leonids formed a tolerably important shower. Mr. T. M. Simpkiss, of Wolverhampton, counted about ninety meteors in one and a half hours between midnight and 1h. 30m. a.m. on November 15, 1863, and from their streaks and directions it was evident the majority of them emanated from the constellation Leo. Very few were observed on the nights of the 12th and 13th, and during the hour from 11h. to 12h. on November 14, Mr. Simpkiss had only counted ten meteors.

The prospect is a fair one that the shower will return on the mornings of November 14 or 15. There appears, however, to be little probability that it will be very brilliant; but it is likely to furnish forty or fifty meteors an hour at the time of its best presentation, and to rival a fairly active return of the Perseid shower. It will be most important to watch its progress, to determine the degree of its activity and length of duration. From my observations in past years, the Leonid radiant appears to be feebly visible from November 9 to November 19, and may be extended beyond those dates. This year the moon will partly interfere with observation setting as follows:—

		h. m.		Age at noon. d. h.
November 12	...	11 38	..	7 5
,, 13	...	12 50	...	8 5
,, 14	...	13 59	...	9 5
,, 15	...	15 9	...	10 5
,, 16	...	16 19	...	11 5

Watches for shooting-stars should therefore be commenced at midnight on the morning of the 13th, at 1 a.m. on the 14th, at 2 a.m. on the 15th, and at 3 a.m. on the 16th. Amongst the features to be specially observed during the progress of the shower may be enumerated the following:—

(1) The time of maximum frequency.
(2) The horary number of Leonids visible.

(3) The position of the radiant point.

(4) The character of the radiation, whether sharply defined or diffuse and scattered over an area.

(5) If an area, find its diameter, and if possible its shape, whether elliptical or round.

(6) The apparent brightness of the meteors, how many are equal to, or brighter than, first magnitude stars.

(7) The duration of the active display.

(8) The duration of the entire shower.

(9) Does the radiant point, as derived on several nights of observation, retain a fixed position or move eastwards amongst the stars? In investigating this feature, it will be necessary to observe the place of the radiant on each night of the shower's visibility. Four or five meteors, if accurately recorded and in or near Leo, will generally be sufficient to indicate a correct position. On nights when the shower is very rich, it will be a good plan to get the radiant from successive half-hourly or hourly intervals, and then, from these independent observations, to derive a mean position for the night.

(10) The duration of the meteor flights in individual cases.

(11) The proportionate number of Leonids leaving streaks to the total number counted.

(12) The time of duration of the streaks. In the case of streaks lasting for some minutes, their drift amongst the stars should be noted.

(13) The colour of the meteors and of their streaks.

There are some other points, but these are among the most important.

As to the numerous minor showers of the period, these must be neglected if the desire is to specially observe the Leonids. Many Taurids are usually seen at the middle of November, but these are easily distinguished from the Leonids, as they move slowly and rarely leave streaks; moreover, their radiant point is placed in a different quarter of the heavens.

To adequately observe and record a meteor shower, at least two persons are necessary, for it is quite impossible for a single observer to give proper attention to all the features. He cannot register the apparent paths and count the number of meteors visible, as his attention will be frequently withdrawn from the sky, and many meteors will altogether elude him. To determine the maximum time of a shower, the observer's attention must be continuously directed to the heavens, and he must carefully note at intervals, say of five minutes, the number of meteors seen. To chart the observed tracts, to determine the radiant, and to note a few other features, quite monopolises one person's attention, and requires an extensive experience for the work to be done properly. Whenever a special meteoric display such as the Leonids is intended to be observed, the services of an assistant are necessary to reckon the visible number of meteors, and determine the time of their maximum frequency. Though the ensuing return of Leonids is not likely to be sufficiently important to call for special effort, there is need of our being prepared, as it may exceed expectation and should be suitably recorded, and it will be sure to offer many interesting facts for observation and discussion.

W. F. Denning.

THE INTERNATIONAL METEOROLOGICAL CONFERENCE IN PARIS.

As has already been announced, this meeting was held in September, under the presidency of Prof. Mascart, and lasted seven days (September 17–23, inclusive). The last meeting of a similar character had been held in Munich in 1891. The Paris meeting was attended by some forty members. Canada and Mexico were represented for the first time; neither Spain, Portugal, Brazil, nor the Argentine States were represented. The Weather Bureau, Washington, sent no one; Mr. Page came from the Hydrographic Office, Washington, but only in a private capacity.

Dr. Hann's absence from the meeting, on the ground of health, was universally regretted.

The programme for discussion consisted of over forty questions, and to these Mr. Wragge, of Brisbane, proposed to add more than a score; but several of his applications were ruled as *ultra vires* for the Conference. Some of the questions on the programme were set aside as either reopening discussions which had been closed years ago, or as being impossible of acceptance; as, for instance, one as to the adoption of a period of 26·67928 days for all meteorological and magnetical phenomena.

The business really done was, briefly, as follows:—

Committees were appointed, as already announced (Nature, October 1), to carry on investigations into (1) terrestrial magnitudes and atmospheric electricity; (2) cloud observations; (3) balloon ascents; (4) sunshine and radiation.

It was recommended, at the suggestion of Mr. Symons, that systematic comparisons of different forms of thermometer exposure be carried out generally, Assmann's apparatus for ventilating thermometers to be one of the forms tested.

The Conference declined to make any recommendation as to a standard anemometer, or as to anemometer exposure.

Several applications were made to the Conference to exert, by resolutions, pressure on Governments with the view of the obtaining of grants for investigations; but these were all ruled as *ultra vires*. Mr. Wragge's requests for stations in Tasmania, and for observations on Mount Wellington, Tasmania, and also on Mount Kosciusko, in Australia, were met by the general declaration that the Conference must welcome the establishment of good stations all over the world.

Dr. Neumayer's proposals to modify existing systems of meteorological telegraphy in Europe were not accepted.

Four questions as to the discussion of phenomena in cyclones were held to be purely theoretical, and therefore unsuitable for discussion at a Conference.

Prof. Mohn submitted some proposals as to the use of the hypsometer. No discussion ensued, but Prof. Mohn's paper will be printed in the appendix to the Report of the Conference.

Dr. Paulsen, of Copenhagen, exhibited monthly ice charts of the North Atlantic, north of the 60th parallel, and received a promise of assistance in their completion from the members present, who were in a position to obtain observations of ice.

Dr. Snellen, of Utrecht, requested the Conference to take measures for convening a new Maritime Conference, to carry on further the work done at the London Conference of 1874. This matter was referred to the International Committee.

The chief feature of the Paris meeting was the attention paid to terrestrial magnetism and atmospheric electricity. The Committee appointed for these subjects held three meetings, of which the minutes will shortly appear; and, as has already been stated, a Committee has been nominated to carry on the discussion of various points which have been raised.

Finally, the International Meteorological Committee has been reappointed with a few modifications, owing to resignations, &c. Its members now are—

Dr. von Bezold (Germany).	Prof. Mohn (Norway).
Dr. Billwiller (Switzerland).	Prof. W. L. Moore (United States).
Admiral Capello (Portugal).	Dr. Paulsen (Denmark).
Mr. Davis (Argentine Republic).	Mr. Russell (New South Wales).
Mr. Eliot (India).	Major-General Rykatcheff (Russia).
Hofrath Hann (Austria).	Mr. Scott (England), *Secretary*.
M. Hepites (Roumania).	Dr. Snellen (Holland).
Prof. Hildebrandsson (Sweden).	Prof. Tacchini (Italy).
Prof. Mascart (France), *President*.	

Robert H. Scott, *Sec. Int. Met. Committee*.

MARS AS SEEN AT THE OPPOSITION IN 1894.

SOME three years ago, M. Camille Flammarion's classical book on the "Planet Mars" was noticed in these columns (NATURE, vol. xlvii. p. 553). This work was a compilation of all the observations made up to that period from the very earliest record, and a thorough discussion of them was given, as was to be expected, in a masterly way. Since that time, however, the planet's surface has been studied by observers in numerous parts of the world, and their observations have been published in various journals and in different languages. Perhaps the most important, or at any rate the most consecutive series, of such observations hails from Flagstaff, Arizona, Mr. Percival Lowell having, at great expense, equipped himself with some fine instruments, and set out for that region to make a systematic study of the surface markings during the opposition of the planet in the year 1894.

It may at first be asked why an observer should choose a place so far away, when most excellent instruments of large aperture are at work nearer home. This question may be answered in a few words. For a study of planetary details, a steady atmosphere is the most essential thing to be secured; the size of the instrument, as Mr. Lowell says, being a matter of quite secondary importance. To convince ourselves we have only to recall the fact how Schiaparelli, with quite a moderate aperture, made numerous discoveries as regards the canals and their doubling, when no one, even with apertures double that of his telescope, could detect the delicate tracery that he saw. It is well known among astronomers that this observer has a marvellously keen eye for observation, but even this would not account for these great differences.

Mr. Lowell, however, wished to set up his instrument under the very best conditions obtainable; and this is why he finally settled upon Arizona, as not only was the planet observable near the zenith there, but observation showed that the air was as pure and as still as he could find anywhere. The result has been that he was able to work from May 24, 1894, to April 3, 1895, practically without a break of any importance during the whole of this period, and the result of his labour will be found in the first volume of the *Annals* of his observatory. This volume, as one would naturally suppose, contains the original data set out in great detail, but practically too technically for the general reader.

For a more general account of the observations, and the results to be drawn from them, we are indebted to him in his book "Mars,"[1] which has been recently published, and of which we propose to give some account in the present article. It must be remembered, before proceeding, that in this volume the observations are confined to those made at Flagstaff by Mr. Lowell, and associated with him Prof. W. H. Pickering and Mr. A. E. Douglass.

It may be thought at first that any book on Mars, to take a high place in the literature on planetary astronomy, must refer to a great extent to the previous work done by other observers. This, certainly, should generally be the case, but there may occasionally be exceptions, and this is one of them, when such a treatment would divert the aim of the book in question. What Mr. Lowell here does is to discuss his own beautiful series of observations (a series quite unique as regards the number of consecutive days of observation), and to make, if possible, plausible deductions from them. Personal equation seems to play a very important *rôle* in the observation of planetary detail, so the more this element is eliminated by dealing with observations made by one man with one instrument, the more should our knowledge o changes, if they occur, be advanced.

[1] "Mars," by Percival Lowell. (London: Longmans, Green, and Co., 1896.)

The subject-matter of this book is divided into six subheads, and we cannot do better than consider each separately. First, then, as regards the general characteristics of the planet's disc. Here we shall limit ourselves, and only refer to the shape of the planet, as an interesting discovery has been made with regard to it. The disc of Mars generally appears perfectly round, but nevertheless it is to some extent flattened at the poles. Nearly all the measures of it have resulted in giving a rather larger value for this flattening than theory seemed to allow. The reason underlying this apparent discrepancy was first noticed after a careful series of measurements of the polar and equatorial diameters. The explanation given, which seems to agree with the facts very well, is that at the edge of the disc there is a fringe of twilight, which affects unequally the equatorial and polar diameters. The equatorial diameter is apparently always too large, and suffers variations due to the different positions of the sun; while in the case of the polar diameter the variations are much less. Under "Atmosphere," the title of the second chapter, this point is again referred to: that we are dealing with an effect of the air, and not one due to mountains, is accounted for by the systematic changes the measured diameters show, which are functions of the sun's position. Calculation shows that the minimum arc of twilight amounts on Mars to 10°.

That Mars possesses an atmosphere has long been known, and indeed it would be difficult to account for the changes that take place on his surface without the intervention of such a medium. This atmosphere is further described as being remarkably free from clouds, a cloud being "a rare and unusual phenomenon." This result is somewhat out of harmony with previous observations, clouds, or what looked very much like them, having been recorded as being distinctly seen passing over and blotting out, locally and temporarily, from view the surface markings.

Mr. Lowell, however, does not say that clouds do not exist there, but that they simply, during the whole time of observation, never blotted out any markings. He admits, however, that the planet's disc has appeared at times unaccountably bright, and that small bright spots have been observed, but nothing in the shape of moving masses in the atmosphere has attracted attention. That there are clouds in the atmosphere he deduces from certain phenomena visible only at the terminator, and observed by Mr. Douglass. During the opposition no less than 736 irregularities on the terminator were observed. The peculiarities of these lie in their shape and distribution: some are projections, others depressions. That they are due to mountains seems, according to Mr. Lowell, to be very improbable when all the facts concerning this planet are taken into account; but that they may be due to clouds, seems more possible. Mr. Lowell discusses this point at some length, and finally considers that these irregularities must be produced by the presence of the latter.

It is perhaps on this point that Mr. Lowell differs most from other observers of Mars. The bright lights seen on the terminator since 1890 seem to indicate the presence of mountains on the Martian surface, so that deformations at the terminator would seem to be more probably due to these than to the assumption of cloud-banks.

We come now to the third chapter of the book, the question of water, and under this heading the polar cap, areography, and seas are discussed. About the first there is little to note. The whole polar area was watched minutely, and found to disappear entirely, an occurrence never before chronicled. During these observations there was always seen a broad blue belt following the cap as it retreated towards the pole, showing that water was actually being formed from the melting of the snow, and

the spots, recorded by Green and Mitchell, were also seen; these were found to consist of land at a higher level than that in the surrounding neighbourhood, and formed of ice-clad slopes which reflected brightly the solar rays.

To place before the reader the different Martian features, Mr. Lowell has adopted a very simple and ingenious plan. He has plotted upon a globe all the details that have been seen at his observatory, and photographed the globe down from twelve different points of view, the negatives being then made "to conform as near as possible to the actual look of the planet." Under "Areography" then the reader makes, so to say, a trip round the planet, each of the most important markings being described in the text. The wonderful network of the canals is almost startling, so clearly do they stand out, and the amount of detail observed surpasses anything that has as yet been done.

In the two illustrations (Figs. 1 and 2) which we reproduce, the reader can see for himself the network of canals and the "oases" at the points of intersection of the canals. The drawings show clearly the canals on the darker portions of the surface markings, quite a modern addition to Martian cartography.

must be on a gigantic scale. If there be inhabitants, then, as Mr. Lowell says, "irrigation must be the chief material concern of their lives."

Turning our attention now to those markings known as canals, we seem to have before us what appears to be a most perfect system of irrigation that could be conceived. These canals form a regular network all over the planet's surface, and apparently pass through the dark as well as the lighter portions of the disc, as gathered from observations of both Messrs. Douglass and Schaeberle. Since they have been so often described before, it is unnecessary to do so here; but one may remark that their number has been considerably increased (more than doubled). Further, at the points were the canals meet one another, there have been observed, in every case, to be spots present. These latter have never been seen isolated: "There is apparently no spot that is not joined to the rest of the system, not only by a canal, but by more than one." The canals and spots further always appear to grow together (see accompanying figures).

Now these canals are not always visible on the surface of the planet; they appear to depend upon the seasons. Observation shows that they undergo a distinct develop-

FIG. 1.—Showing the region about the Lacus Solis. Longitude 60° on the meridian.

FIG. 2.—The region about Mare Cimmerium and Trivium Charontis. Longitude 210° on the meridian.

With regard to the so-called "Seas," that is, the blue-green areas, we are told that important facts conspire together to throw grave doubt upon their aquatic character. The two chief of these are, first, that hundreds of thousands of square miles of them disappear in an amazingly short space of time; and, second, that polariscope observations give no indications of polarisation. Two questions then arise: first, where then does all the water, formed from the melting of the polar cap, go? and what are, then, these blue-green areas? The latter are, according to Mr. Lowell, areas of vegetation, and they have been observed to alter their tints as the seasons on the planet progress; he suggests, however, that they were probably once seas, but the supply of water has now so diminished that it only flows in the deepest channels. He defines them as being at present midway in evolution between the seas of our earth and those of the moon.

With such a state of affairs, a small water supply, the inhabitants of Mars must, to exist, have a very elaborate and scientific means of utilising every drop they can procure; or, in other words, their system of irrigation

ment, and it is here that a clue may be found to their origin. Let us regard this "development" as seen and recorded by Mr. Lowell. A canal, according to him, alters in visibility for some reason connected with itself; it grows into existence, but is always constant in position. Their visible development apparently follows the melting of the polar snows. They become distinct when the melting has considerably progressed, and more so as the season advances. Those which are visible first lie to the southward, *i.e.* nearer to the south pole. It may be mentioned here that the southern pole was tilted during this opposition towards the earth. Latitude and proximity to dark regions are the two main factors for early visibility. Canals running north and south generally become visible before those running east and west.

With regard to the doubling of the canals, Mr. Lowell's observations have led him to discover that this does not occur all of a sudden, as has generally been understood, but that there is an apparent mode of development in the process.

In the case of the Ganges, he says: "Hints of germina-

tion were visible when I first looked at it in August. . . . By moments of better seeing its two sides showed darker than its middle; that is, it was already double in embryo, with a dusky middle-ground between the twin lines. In October the doubling had sensibly progressed . . . the ground between the twin lines had grown lighter. By November the doubling was unmistakable."

Let us now turn again to the canals, and see what explanation Mr. Lowell gives to account for their origin and subsequent duplication. The idea he adopts is one that has already been suggested by Schiaparelli and Pickering, namely vegetation. The water in its passage from the pole fills a canal, and thus irrigates the country on both sides for agricultural pursuits. The actual canals themselves we do not see; but at a later period the vegetation raised thereby becomes apparent, which gives us the visible canals. The darker lines which cross the dark markings, or the more permanent areas of vegetation, represent also a more advanced growth of vegetation, caused by the supply of water, which passes on its journey to fill those in the brighter regions. Observation at Flagstaff has shown that "there is no canal in the dark areas which does not connect with one in the brighter regions."

So much, then, for the canals and their origin; but how about their apparent duplication? Mr. Lowell, however, has little to say on this point.

"Exactly what takes place . . . I cannot pretend to say. It has been suggested that a progressive ripening of vegetation from the centre to the edges might cause a broad swath of green to become seemingly two. There are facts, however, that do not tally with this view."

From the above extract, it will be seen that Mr. Lowell does not like to commit himself to any statement in explanation of this phenomenon—at any rate, not at present. There seems, however, many reasons to believe that if the canals be due to vegetation, then their doubling is most probably the results also of vegetation; how this comes about is, however, still a moot point.

One of the best instances we have on the earth, of a large strip of land being fertilised once a year directly by an inundation of a large river, is that of the Nile valley. In following, however, the phases which the country on each side of her banks undergoes at the time of and after the flood, it is difficult to account for the development of the duplicity as observed on the Martian disc. Perhaps the irrigation scheme on the surface of Mars has been carried to such an extreme degree of development, that smaller parallel canals on each side of, and some distance from, the larger ones have been constructed so as to become filled and eventually cut off from the main canal when the water commences to recede. In this way the land would be best fertilised at first on the banks of the main canal, but at a later date on those of the smaller canals. The appearance of a canal should then begin by being single; as time went on it should broaden, and eventually become double, the two most fertilised strips being parallel, but at some distance from the main canal. The connecting channels between the main and lateral canals, or rather, the vegetation along these lines, would most probably be invisible on account of their extreme shortness.

Such an explanation as this overcomes the difficulty that there are some canals that do not appear double. One has only to assume that the side canals in these cases have not yet been constructed, and duplicity is on this hypothesis impossible. Whatever the real explanation may be, it is certain that greater attention must be paid to the actual development and fading, before this problem can be looked upon as really solved.

In conclusion, we cannot help remarking on the very logical handling of the subject in this volume. The author makes out, further, a very good case for the hypothesis of "vegetation," which will be hard to oppose. It does seem, however, rather premature for him to draw such decided conclusions from this, his first large series of observations; but his own words show that even these views may be considerably changed by future observation, and he has not, therefore, tied himself too fast to them. In the chapter on the germination of the canals, he remarks that "perhaps we may learn considerably more about it at the next opposition. At this the tendril end of our knowledge of our neighbour we cannot expect hard wood."

The observations of Mr. Lowell have, nevertheless, added greatly to our knowledge of the surface-markings on this planet, and astronomical science owes him a debt of gratitude for the energy he has displayed in fitting out and conducting this expedition, that has been rewarded with such interesting and valuable results.

The book itself not only appeals to professional astronomers, but should be read by all those interested in observations of Mars, for it is written in language that will be found comprehensible even to the uninitiated. The illustrations, which are numerous, are by no means lacking in quality, and considerably enhance the value of the book.

WILLIAM J. S. LOCKYER.

THE SCIENTIFIC DEPARTMENT OF THE IMPERIAL INSTITUTE.

THE extended organisation of the experimental branch of the Scientific and Technical Research Department of the Imperial Institute is now nearly complete, and the whole of the west corridor of the second floor is occupied by well-equipped laboratories, instrument rooms, and sample examination rooms, whilst the recently appointed staff of skilled chemists is already engaged in the scientific and technical investigation of numerous Indian and Colonial products, which are likely to prove of commercial importance or of scientific interest.

The winter course of lectures will be opened on Monday, November 9, at 8.30 p.m. with a discourse by Prof. Wyndham Dunstan, F.R.S., the recently appointed Director of the Scientific Department, the subject of which will be "Illustrations of some of the work of the Scientific and Technical Research Department of the Imperial Institute." After the lecture the research laboratories of the department will be open for the inspection of visitors, and a number of interesting exhibits will be on view.

On November 16, Mr. William Crookes, F.R.S., will deliver the first of two illustrated lectures on the "Diamond Fields of Kimberley," in connection with which a number of specimens and experiments of great interest will be shown. Among other topics Mr. Crookes will discuss the nature and probable origin of the diamond, and will give an account of recent researches of his own. On the occasion of the first lecture, Lord Loch will preside.

On the two remaining Monday evenings in November, illustrated lectures will be given by Prof. J. W. Judd, C.B., F.R.S., the Dean of the Royal College of Science, on "Rubies, Natural and Artificial, with special reference to their Occurrence in the British Empire" (November 23), and by Dr. J. H. Bryan, F.R.S., on "Flight, natural and artificial" (November 30).

Succeeding lectures, the dates of which will be duly announced, will be given by Prof. A. H. Church, F.R.S., Professor of Chemistry to the Royal Academy, on "Some Food-grains of India"; by Dr. Schlich, C.I.E., of the Royal Indian Engineering College, Cooper's Hill, on "The Timber Supply of the British Empire"; by the Hon. W. Pember Reeves, Agent-General for New Zealand, on "The Hot Springs District of New Zealand";

by Colonel Watson, R.E., on "Schools of Modern Oriental Studies"; by Mr. A. Montefiore Brice, on "The Results of the Jackson-Harmsworth Expedition"; a course of three lectures, by Dr. J. L. W. Thudichum, on "The Nature and Manufacture of Wine, with special reference to Colonial Wines"; by Mr. J. Norman Lockyer, C.B., F.R.S., on "How the British Empire aids in Solar Inquiries"; by Prof. W. E. Ayrton, F.R.S., on "Sixty Years of Submarine Telegraphy"; by Mr. Spencer Pickering, F.R.S., on "The Woburn Experimental Fruit Farm." These lectures are open to Fellows of the Institute, and to persons introduced by them.

We warmly congratulate the Executive Council on the new departures. The acknowledgment of the importance of science on the part of the Governing Body comes none too soon.

Much remains to be done in this direction before the Institute can be held to fill the place which many of its best wishers consider it ought to occupy.

FRANÇOIS FELIX TISSERAND.

IT is impossible that we should have learnt the death of an astronomer so eminent as M. Tisserand, the Director of the Paris Observatory, without feelings of the deepest regret, yet its terrible suddenness lends an added note of pathos to the melancholy event. From the report of the Paris correspondent of the *Times*, it appears that on the evening of Monday, October 19, M. Tisserand was present at the dinner celebrating the signing of the marriage contract of the son of the late Admiral Mouchez. On the following morning, apparently without the slightest warning, M. Tisserand expired, the cause of death being congestion of the brain. Astronomy, not only in France, but wherever the science is studied, has thus sustained a tremendous and irreparable loss, and especially will sympathy be extended to the members of the staff of the Paris Observatory, who, twice within a few years, have been deprived of their chief.

François Felix Tisserand was born in the department of Côte d'Or on January 15, 1845. He entered the Normal School at Paris in 1863, and in 1868 gained his Doctorate in Science. Although elected an *agrégé* in 1866, he did not take up the duty of giving instruction, but joined the staff of the Imperial Observatory as assistant astronomer. In 1873, the astronomical service was reorganised by M. Le Verrier, and M. Tisserand was nominated Director of the Toulouse Observatory, and Professor of Astronomy in the Faculty of Sciences of the same town. Subsequently he became Professor of Theoretical Mechanics at Paris, but was transferred, in May 1883, to the chair of Mathematical Astronomy. In this year he began that series of lectures at the Sorbonne, the delivery of which has been attended with the happiest results, for these lectures, given first as the deputy, and subsequently as the successor to M. Puiseux, led eventually to the preparation of that great work with which M. Tisserand's name will ever be connected, the "Traité de mécanique céleste." Though engaged for some twenty years on this work, and necessarily much occupied with official duties, his energy was not exhausted, nor his services to science limited by this task, which few men could have undertaken and brought to a successful issue. In 1874, he accompanied M. Janssen to Japan for the purpose of observing the transit of Venus, and a few years later he was charged with the duty of completing Delaunay's "Théorie de la Lune." Some of the results of this close study of Delaunay's work are shown in the third volume of the "Traité," in the chapters entitled "Réflexions sur la théorie de Delaunay."

M. Tisserand's original memoirs and papers, the most important of which were contributed, though not exclusively, to the *Comptes rendus*, indicate a remarkable activity, and even an exceptional versatility, if that be possible within the range of astronomical science. These papers are far too numerous to mention in detail, but among them are valuable contributions on the theory of interpolation, on problems presented by the minor planets and meteors, on observations of sun spots, &c. While at Toulouse, M. Tisserand made a collection of exercises in the infinitesimal calculus, which he published in 1876. But the subject with which M. Tisserand's name will always be associated is Celestial Mechanics. The first volume of his "Traité de Mécanique céleste" appeared in 1888; the fourth, which was understood to be the last, has very recently been placed in the hands of astronomers. This is not the place to attempt any analysis of that great work, of which perhaps it is not too much to say, that it will render a similar service to the astronomers of the next century, that the work of Laplace did to those of the last. Herein will be found a unique collection of methods, exhibiting great elegance in the mathematical formulæ, and everywhere enriched by critical and historical reference to the original work of other masters in particular departments. This work will always stand as a worthy monument to the memory of its author.

In 1892, on the death of Admiral Mouchez, M. Tisserand was selected to fill the position of Director of the Paris Observatory. This appointment carried with it, almost of necessity, that of the Presidency of the *Comité permanent*, to whom is entrusted the details connected with the preparation of the *Carte du Ciel*. How loyally he has struggled to give impetus to the scheme that his predecessor had so much at heart, is shown by the various reports which he has presented to the Council of the Observatory, and of which summaries have appeared from time to time in NATURE. Under his auspices, a bureau for the measurement of negatives has been established or extended, additional instruments have been provided for measurement, and energy and progress have everywhere marked his short rule. He has struggled manfully with the arrears of meridian observations, and had schemed a plan of publication reaching as far as 1899. While thoughtful of the necessities of the old astronomy, he has not been unmindful of the new, as the free hand given to M. Deslandres, and the work emanating from the spectroscopic department, abundantly prove. Cut off at the early age of fifty-one, and after so short an occupancy of the post of Director, he has perhaps not had full opportunity to declare his capacity in many directions, but he has done more than enough to justify his selection to the important post he filled, and to furnish a model to his successor. For he worthily upheld the traditions of the institution; and it is not saying too much, although it is saying a very great deal, when we affirm that he was a worthy successor in the line of illustrious astronomers who had preceded him in the control of the Paris Observatory. He had received an abundance of honours, too long to fully enumerate, for the scientific societies of all nations were proud to enrol him among the list of their honoured associates. He was decorated with the Legion of Honour in 1874, and four years later succeeded Le Verrier among the full members of the Academy. He was a member of the Bureau des Longitudes, and held other positions of dignity and credit. The St. Petersburg Academy voted him the *Prix Schubert*, and the Royal Astronomical Society elected him a Foreign Associate in 1881. W. E. P.

DR. HENRY TRIMEN.

THE friends of Henry Trimen who saw him during his last visit to England—a twelvemonth ago last summer—would not be altogether unprepared for a serious turn in the malady, or rather maladies, from which he suffered; yet the news of his death on the

16th inst. came as a surprise, even to those best acquainted with his condition. For several years he suffered from deafness, which at length became absolute, and then gradual paralysis of the lower limbs set in. This terminated not long since in utter helplessness so far as his legs were concerned, and functional complications arising, he succumbed sooner than was expected. He bore his afflictions with wonderful fortitude, and even cheerfulness; and his only desire was to be spared to complete his great work, the "Handbook to the Flora of Ceylon." But this was not to be. It is to be hoped, however, that a competent botanist will be found to complete this important and admirably-planned publication.

Henry Trimen was born in London in 1843, and educated at King's College. In 1865 he graduated M.B., but he never practised medicine. His favourite study was botany, and he at first specially devoted himself to the British flora and the sources of vegetable drugs. In 1867 he was appointed Lecturer on Botany at St. Mary's Hospital Medical School; and in 1869, he entered the Botanical Department of the British Museum as senior assistant. In the meantime he had published a number of contributions to British botany, chiefly relating to the flora of Surrey, of Hampshire, and especially of Middlesex. His first work appeared in the *Phytologist* in 1862. Soon he became acquainted with W. T. Thiselton-Dyer, the present Director of Kew Gardens, and the result was their admirable "Flora of Middlesex," published in 1869. This work still holds a position in the first rank among county "Floras." In 1866, Trimen discovered *Wolffia arrhiza* at Staines; the first locality recorded for it in England. It was in that year that the writer became acquainted with Trimen and his associate, and made various excursions with them collecting materials for their "Flora." In 1870, Trimen joined Dr. B. Seemann in editing the *Journal of Botany*, and on the death of the latter he assumed the full responsibilities of editor, which he continued to exercise until he went to Ceylon. Concurrently he was conducting his investigations in medical botany, and he associated himself with Robert Bentley in the publication of an illustrated work on "Medicinal Plants"—a work of much research, comprising four volumes containing upwards of 300 coloured plates. Passing over many minor events, we come to the period when he was appointed to succeed Dr. Thwaites in the important and onerous duties of Director of the Botanic Gardens of Ceylon—duties he discharged in a manner satisfactory to the home authorities and the colonists. His annual reports are models of what such reports should be. He at once took up the study of the native flora, and was soon actively engaged in the introduction of valuable economic plants of other countries for cultivation in Ceylon. The first volume of his "Handbook" appeared in 1893; the second in 1894; the third in 1895; and from his last letters we learn that he was still working with a will, in spite of his afflictions.

As a botanist, Trimen was a man of great attainments. As a friend, he was sympathetic, sincere, and constant. His work was always thoroughly and conscientiously performed, and is consequently of an enduring nature. This was recognised in his being elected a Fellow of the Royal Society in 1883. W. BOTTING HEMSLEY.

NOTES.

As briefly announced in these columns on September 17, a Nansen research fund is being raised in Norway. Its object is to commemorate the remarkable Arctic expedition of this explorer by the foundation of a fund called "The Fridtjof Nansen Fund" for scientific research. The *Times* of October 23 says it is intended that, by this means, research in various departments of science shall be promoted, and the results published. Dr. Nansen himself may be appointed director, but there will be no salary attached to the office, as the whole of the yearly products of the fund will be devoted to the objects stated. Up to the present no less than 300,000 kroner have been subscribed. Consul A. Herberg, Dr. Nansen's friend, has contributed 50,000 kroner; while others, besides numerous Norwegians, are Baron Oscar Dickson, 25,000 kroner; Dr. A. Nobel, 25,000 kroner; and Prof. Frankland, 1000 kroner. It is stated that the fund will probably be placed under the care of the Christiania University, the Norwegian Society of Science, and the Bergen Museum. If any wealthy Englishmen, who are admirers of Dr. Nansen, care to contribute, they should communicate with the Committee of the "Fridtjof Nansens fond til indenskabens fremme, University, Christiania."

FROM the *British Central African Gazette* we learn that Mr. Alexander Whyte, Sir Harry Johnston's scientific assistant in British Central Africa, has just returned from a successful expedition into the Nyika plateau on the north-eastern shores of Lake Nyasa, and has made a large collection. The flora of this district proved to be most interesting, resembling that of Mount Milanji in the south of Nyasaland, but differing from it in many respects. Mr. Whyte failed to find any trace of a conifer, but the range is richer in heaths than Milanji. He obtained 6000 specimens of plants and a large zoological collection.

AT a meeting of the Physical Society, to be held on October 30, it will be proposed (*inter alia*) that the subscription to the Society be increased to £2 2*s*., that life members be invited to contribute an annual subscription of £1 1*s*., and that, in future, members be styled "Fellows of the Physical Society of London."

A NOTABLE experiment in kite-flying was made at Blue Hill Observatory, N.J., on October 8. The greatest height yet reached by kites was attained, records being made at a height of 9385 feet above sea-level. More than three miles of piano wire were paid out, the ascension beginning at 9.15 a.m., and continuing till 9.5 p.m. The pull on the wire was from 20 to 50 pounds at the start, and ranged from 50 to 95 pounds at the highest point, after which it slowly decreased. The instrument entered and passed through clouds, as shown by the record of very dry air above them. The temperature fell from 46° at the hill to 20° at an altitude of 8750 feet. The meteorograph record in ink, on a revolving cylinder run by clockwork, was the best yet obtained. The lifting force consisted of seven Eddy, or tailless, and two Hargrave, or box kites, from 6 to 9 feet in diameter. The instrument was more than a mile high during three hours.

THE King of Servia has conferred upon Prof. D. E. Hughes, F.R.S., the Grand Officer's Star and Collar of the Royal Order of Takovo.

MR. J. WOLFE BARRY, C.B., F.R.S., is to deliver his presidential address to the Institution of Civil Engineers on November 3, at the inauguration of the seventy-eighth session of the society.

MR. J. DE WINTER, Assistant at the Royal Zoological Society's Garden at Antwerp, has been appointed Superintendent of the Zoological Garden at Gizeh, Cairo, and will shortly leave for Egypt.

THE first meeting of the British Ornithologists' Club for the present session was held at Frascati's Restaurant, Oxford Street, on Wednesday, the 22nd inst., and was attended by thirty-four members and guests. After some preliminary business Mr. Sclater, who was in the chair, gave an address on the progress of Ornithology during the past twelvemonths.

Various communications and exhibitions followed, amongst which was an account of the occurrence in England of a bird new to the British Avifauna. This was the greenish Willow-warbler, *Phylloscopus viridanus*, Blyth, an inhabitant of North India and Western Asia, which has previously occurred as far west as Heligoland.

Mr. J. H. Greathead, the engineer, who wil be chiefly remembered as the pioneer in the system of tunnelling by means of the shield which bears his name, died on Wednesday, October 21.

We notice with much regret the announcement of the death of Dr. George Harley. Dr. Harley was born on February 12, 1829, at Haddington. At the end of his sixteenth year he matriculated as a medical student at the University of Edinburgh, graduating there in 1850. He left Edinburgh in the following year, and went to Paris to pursue his scientific studies. After two years' residence there he proceeded to Germany, where he continued his studies at the Universities of Würzburg, Berlin, Vienna, and Heidelberg. On his return to England he became Curator of the Anatomical Museum at University College, and subsequently he was appointed to its lectureship on practical physiology and histology. In 1859 he was appointed to the professorship of medical jurisprudence at the College, and shortly afterwards was made physician to University College Hospital. In 1861 he won the triennial prize of fifty guineas offered by the Royal College of Surgeons, for an essay "On the Anatomy and Physiology of the Supra-Renal Bodies." Up to 1863 he had contributed no fewer than twenty-one separate memoirs to science, which fact was recognised by his election into the Royal Society in 1865. He was already at that time a corresponding member of the Academy of Sciences, of Bavaria, and of the Academy of Medicine, of Madrid. It was Dr. George Harley who proposed what is known as the A.C.E. anæsthetic, a mixture of absolute alcohol, chloroform, and sulphuric ether, in the proportion : 2 : 3. His suggestion was adopted by the Chloroform Committee of the Royal Medico-Chirurgical Society, and soon it became widely accepted as being the safest of any of the known anæsthetics. He was the author of several valuable works on medical subjects.

The opening of a new Pathological Institute at Glasgow is reported in the *Lancet*. The Institute is an addition to the Western Infirmary, and every care has been taken to ensure its adequacy for its purpose. It comprises a large lecture-room, post-mortem laboratory, practical class-room, chemical and bacteriological laboratories, photographic room, and private working rooms in which original researches may be conducted, as well as a large and commodious museum. The total expenditure has exceeded £15,000. At the inaugural ceremony Prof. Gairdner delivered an address on the relation of the study of pathology to the art of medicine and the public health. Speeches were also delivered by Prof. Coats, Prof. Boyce (Liverpool), Dr. Leith (Edinburgh), Mr. J. G. A. Baird, M.P., and Mr. J. Wilson, M.P.

The new session of the Royal Geographica Society will open on November 10 with a brief introductory address by the President, Sir Clements Markham, and a description, by Mr. A. Montefiore Brice, of last year's work of the Jackson-Harmsworth Arctic Expedition. On November 23, Lieut. Vandeleur will give a paper on Uganda, Unyoro, and the Upper Nile Region, and on December 7, Colonel J. K. Trotter will describe his journey to the sources of the Niger. Dr. Fridtjof Nansen will give an account of the results of his recent expedition across the North Polar area, at a meeting to be held towards the end of January. Other papers, which may be expected after Christmas, are the following:—Exploration in Spitzbergen, by Sir W. Martin Conway; a journey through Senegambia, by Harry W. Lake; an expedition to the Barotse country, by Captain A. S. Gibbons and his companions, Percy C. Reid and Captain Bertrand; the cañons of Southern Italy, by R. S. Günther; journeys in Tripoli, by H. S. Cowper; journeys in Central Asia, by Dr. Sven Hedin; exploration on the South of Hudson's Bay, by Dr. Robert Bell. Special meetings will be held in connection with the 400th anniversary of the discovery of Newfoundland by Cabot, and of the Cape route to India by Vasco da Gama. Under the joint auspices of the Society and the London University Extension, Mr. H. J. Mackinder is giving a course of twenty-five lectures on the geography of Europe, Asia and Northern Africa, in illustration of the methods and principles of modern geography, at Gresham College, Basinghall Street, E.C.

So many popular periodicals now consist entirely of snippets, that the public taste for more substantial literature has been impaired. It is, therefore, with no small degree of satisfaction that we note the counteracting influence of the *Daily Chronicle*. At the beginning of September that journal published a paper by Dr. Nansen on his Arctic expedition, and also a detailed communication from Captain Sverdrup on the voyage of the *Fram*. The enterprise which secured these interesting narratives is again shown by the announcement that the *Daily Chronicle* of November 2, 3, and 4, will contain a signed description by Nansen himself of his recent expedition, accompanied by a map of the course of the *Fram* and of his sledge journey. The narrative will be illustrated by sixteen drawings from photographs. The first part will describe the general plan of the expedition, and the drifting of the *Fram* in the Polar current; the second will deal with the journey of Nansen and Johansen from March 1895 until they met Mr. Jackson; and the third part will be devoted to the voyage of the *Fram* after they left her. The articles will thus epitomise the whole of the results of the expedition; and we are glad that a contribution of this character will appear in a daily paper appealing to such a wide public as that commanded by our very active contemporary.

The Pasteur Institute of India is now within measurable distance of becoming an accomplished fact. From a report in the Allahabad *Pioneer Mail* of a meeting of the Council, on September 10, we learn that 70,000 rupees has already been collected in subscriptions from the general public, and it is estimated that with 50,000 rupees more the building might be commenced, equipment provided, and work begun at a very early date. In addition to the contributions referred to, annual subscriptions amounting to 2873 rupees have been promised by well-disposed Municipal and District Boards, and from the purses of private individuals in the Punjab, for the maintenance of the institution; and if this sum be added to 1500 rupees, *i.e.* the interest at 3 per cent. on a fund of 50,000 rupees now available for investment, there is already at the disposal of the Body of Control a total annual income of 4373 rupees. The question of a site for the Institute has not yet been settled. The scope of the proposed Institute was described in these columns on September 17 (p. 483).

Mr. Gosselin, of the British Embassy in Berlin, mentions in a recent report (says the *Times*) that the question of preserving big game in German East Africa has been under the consideration of the local authorities for some time past, and a regulation has been notified at Dar-es-Salaam which it is hoped will do something towards checking the wanton destruction of elephants and other indigenous animals. Under this regulation every hunter must take out an annual licence, for which the fee varies from five to 500 rupees, the former being the ordinary fee for natives, the latter for elephant and rhinoceros hunting and

for the members of sporting expeditions into the interior. Licences are not needed for the purpose of obtaining food, nor for shooting game damaging cultivated land, nor for shooting apes, beasts of prey, wild boars, reptiles, and all birds except ostriches and cranes. Whatever the circumstances the shooting is prohibited of all young game—calves, foals, young elephants, either tuskless or having tusks under three kilos, all female game if recognisable—except, of course, those in the above category of unprotected animals. Further, in the Moschi district of Kilima-Njaro, no one, whether possessing a licence or not, is allowed without the special permission of the Governor to shoot antelopes, giraffes, buffaloes, ostriches, and cranes. Further, special permission must be obtained to hunt these with nets, by kindling fires, or by big drives. Those who are not natives have also to pay 100 rupees for the first elephant killed and 250 for each additional one, and 50 rupees for the first rhinoceros and 150 for each succeeding one. Special game preserves are also to be established, and Major von Wissmann, in a circular to the local officers, explains that no shooting whatever will be allowed in these without special permission from the Government. The reserves will be of interest to science as a means of preserving from extirpation the rarer species, and the Governor calls for suggestions as to the best places for them. They are to extend in each direction at least ten hours' journey on foot. He further asks for suggestions as to hippopotamus reserves, where injury would not be done to plantations. Two districts are already notified as game sanctuaries. Major von Wissmann further suggests that the station authorities should endeavour to domesticate zebras (especially when crossed with muscat and other asses and horses), ostriches, and hyæna dogs crossed with European breeds. Mr. Gosselin remarks that the best means of preventing the extermination of elephants would be to fix by international agreement amongst all the Powers on the East African coast a close time for elephants, and to render illegal the exportation or sale of tusks under a certain age.

An interesting report has been drawn up by Dr. M. C. Schuyten on the influence of atmospheric variations on the voluntary attention of school-children (*Bulletin de l'Académie Royale de Belgique*). Observations were made in four different schools in Belgium, the method adopted being to give the children in class a passage to read from a book, and to note whether their eyes were fixed on the pages. The general conclusions arrived at by statistical tabulation of the results were as follows: (1) The attention of children varies inversely with the temperature of the air, being greater in winter than in summer; (2) it is greater in the higher than in the lower classes; (3) it is higher among girls than boys, and the difference is greatest in winter; (4) it decreases from 8.30 to 11 a.m., and also from 2 to 4 p.m.; at 2 p.m. it is greater than at 11 a.m., but less than at 8.30 a.m.

Dr. Nansen's work on his expedition to the North Pole will be published in the English language by Messrs. Archibald Constable and Co.

The Rev. Edmund Ledger will give a course of four lectures upon "Eclipses of the Sun," at Gresham College, Basinghall Street, on November 3, 4, 5, and 6. The lectures are free, and they commence at 6.0 p.m.

The editor of the *Journal of Malacology* requests us to say that he is still desirous of obtaining living specimens of worm-eating slugs (*Testacella*), so as to add to the records he has of the distribution of these animals in the British Isles, and which he hopes to be soon in a position to publish. All communications should be addressed to Wilfred Mark Webb, "Ellerie," Crescent Road, Brentwood, Essex.

During November, popular science lectures will be delivered on Tuesday evenings, at 8.30, at the Royal Victoria Hall, Waterloo Road, as follows:—November 3, Rev. J. Grant Mills, on "St. Thomas's Hospital, Past and Present"; November 10, Prof. Carlton J. Lambert, on "A Pennyworth of Gas; what it is, and what we can do with it"; November 17, Dr. Bertram L. Abrahams, on "The Eye"; November 24, Lieut. Darwin, on "A Popular Account of an Astronomical Expedition."

A meeting of the Institution of Mechanical Engineers will be held on Wednesday and Thursday, November 4 and 5. The chair will be taken at half-past seven p.m. on each evening by the President, Mr. E. Windsor Richards. The following papers will be read and discussed, as far as time permits:—"Research Committee on the Value of the Steam-Jacket; Experiment on a Locomotive Engine," by Prof. T. Hudson Beare and Mr. Bryan Donkin; "Transmission of Heat from Surface Condensation through Metal Cylinders," by Lieut.-Colonel English and Mr. Bryan Donkin; "Breakdowns of Stationary Steam-Engines," by Mr. Michael Longridge.

The *Kew Bulletin* (Nos. 113 and 114) gives an account of the progress, since its foundation in 1892, of the botanic station at Belize, British Honduras. It has been founded by the Governor, Sir Alfred Moloney, for the purpose of experimenting on the tropical staples most suitable for the climate. Since the decline in the production of mahogany, due to African competition, the export of logwood has been almost the sole source of wealth to the colony. It would appear, however, that British Honduras is very favourably situated, as regards soil and climate, for the production of many other tropical commodities, and has excellent communication with the Southern States of America.

It has long been known that during the slow oxidation of a number of substances in oxygen or air, part of the oxygen becomes endowed with peculiarly active properties. Various explanations of the phenomenon have been offered; the tendency of recent investigation, however, seems to be to show that the oxygen molecules split up into atoms (probably with opposite electrical charges), one of which brings about oxidation, the other forming the so-called active oxygen. An interesting contribution to our knowledge of this subject is just published in the form of an inaugural dissertation by Mr. W. P. Jorissen (Amsterdam, 1896). He finds that triethyl-phosphine, in presence of water (in the dry state the reaction proceeds further), takes up from the air a quantity of oxygen corresponding to the formation of triethyl phosphine oxide, $P(C_2H_5)_3O$. Benzaldehyde is similarly converted into benzoic acid. If, however, a substance such as a solution of indigo, which is not oxidised by ordinary oxygen, be present, twice as much oxygen is absorbed, the indigo being decolourised. For each atom of oxygen used up in oxidising the triethyl phosphine or benzaldehyde an atom of "active" oxygen is produced, which acts on the indigo. The changes occurring during slow oxidation are, however, frequently more complicated. For example, if a mixture of benzaldehyde and acetic anhydride be exposed to the air, oxidation occurs with formation of benzoyl peroxide and ozone. Jorissen supposes the reaction to proceed as follows.

$$2C_6H_5COH + 2O_2 = 2C_6H_5COOH + 2O \text{ (active)}$$
$$2C_6H_5COOH + O_2 + 2O \text{ (active)} = (C_6H_5CO)_2O_2 + H_2O + O_3.$$

The acetic anhydride serves probably as a dehydrating agent. In conformity with these equations, it is found that twice as much oxygen is absorbed in this reaction as if the benzaldehyde had simply been oxidised to benzoic acid. His own experiments, taken together with previously published results, lead the author to the conclusion that "a body undergoing slow oxidation

converts the same quantity of oxygen into the 'active' state, as it itself takes up in the formation of the *primary* product of oxidation."

THE theory of electrolytic dissociation, which is of such great importance in modern chemical speculations, has been hitherto almost exclusively confined, in its application, to aqueous solutions. Notwithstanding the few investigations of the electrical conductivity of solutions of salts in other solvents which have already appeared, our knowledge of the ionisation of such solutions is still very fragmentary. An extensive series of measurements of the conductivity of solutions of salts in methyl alcohol, published by Messrs. Zelinsky and Krapiwin in the current number of the *Zeitschrift für physikalische Chemie*, is therefore very welcome. They find that the methyl alcohol solutions have, in many cases, conductivities of the same order of magnitude as the aqueous solutions. For example, the conductivities of methyl alcoholic and aqueous solutions of potassium bromide of the same strength are in the ratio 1 : 1·5 approximately, with tetramethyl-ammonium bromide the ratio is 1·1, and the dilute alcoholic solutions of trimethylsulphine iodide possess almost the same conductivities as the aqueous solutions. The influence of the change of solvent is more marked with the acids; oxalic and trichloracetic acids, for example, the aqueous solutions of which are good conductors, possess very small conductivities in methyl alcoholic solution. In all cases the molecular conductivity increases with increasing dilution; he limit does not appear, however, to have been reached for any of the substances examined. The molecu ar conductivity of some of the badly conducting substances increases with the dilution in much the same way as is the case with aqueous solutions of feebly dissociated substances, viz. approximately in proportion to the square root of the dilution. For example, the molecule conductivity of a solution cf tin diethyl iodide, $Sn(C_2H_5)_2I_2$, increases 1·36 times when the dilution is doubled, i nstead of $\sqrt{2}$ = 1·41 times; with trichloracetic acid the increase s 1·365 times. A curious fact, no explanation of which is as yet forthcoming, is that the substitution of a sma quantity of alcohol for water diminishes the conductivity of the aqueous solutions considerably, and that the addition of a little water to the alcohol used has the same effect on the alcoholic solutions. Measurements of the conductivities of some salts dissolved in a mixture of equal parts by weight of methyl alcohol and water, show that they are almost exactly half those found in pure water, or 25–30 per cent. smaller than those found in pure methyl alcohol.

THE additions to the Zoological Society's Gardens during the past week include three Purple-faced Monkeys (*Semnopithecu, leucoprymnus*) from Ceylon, a Rhesus Monkey (*Macacus rhesus*), a —— Bamboo Rat (*Rhizomys*, sp. inc.), a —— Mouse (*Mus*, sp. inc), three —— Doves (*Turtur*, sp. inc.), eleven Burmese Tortoises (*Testudo elongata*), seven Black-backed Tortoises (*Testudo platynota*), three Ceylonese Terrapins (*Nicoria trijuga*, var. *edeniana*), four Shielded River Turtles (*Emys scutata*), five Cocteau's Geckos (*Hemidactylus coctæi*), twelve Verticillated Geckos (*Gecko verticillatus*), six Yellowish Monitors (*Varanus flavescens*), six Doria's Lizards (*Mabuia doriæ*), six Emma's Lizards (*Calotes emma*), three Bell's Lizards (*Liolepis belliana*), five Robed Snakes (*Tropidonotus stolatus*), two Fishing Snakes (*Tropidonotus piscator*), a Rayed Snake (*Coluber radiatus*), a Condenar Sand-Snake (*Psammophis condanarus*), two Well-spotted Snakes (*Dipsadomorphus multimaculatus*), two Olivaceus Water-Snakes (*Hypsirhina enhydris*), an Aulic Snake (*Lycodon aulicus*), two Ornamental Tree Snakes (*Chrysopelea ornata*), four Grass-Green Tree Snakes (*Dryophis prosina*). two Long-snouted Snakes (*Passerita mycterizans*), a Hamadryad (*Ophiophagus elaps*), a Banded Bungarus (*Bungarus fasciatus*), an Indian Cobra (*Naia tripudians*), three Russell's Vipers (*Vipera russelli*), eleven Green Pit-Vipers (*Lachesis gramineus*) from Burmah, presented by Mr. W. C. Bligh; a Black Lemur (*Lemur macao*) from Madagascar, presented by Captain H. Talboys; a Black Wallaby (*Halmaturus ualabatus*) from New South Wales, presented by Mr. Malcolm Watson; a Moorish Tortoise (*Testudo mauritanica*) from North Africa, presented by Mr. R. M. C. Souper; a Yellow-cheeked Lemur (*Lemur xanthomystax*) from Madagascar, presented by Mr. H. O. Townshend; a Smith's Dwarf Lemur (*Microcebus smithi*) from Madagascar, presented by Dr. Hubert E. J. Bliss; two Panolia Deer (*Cervus eldi*) from Burmah, deposited; two Virginian Eagle Owls (*Bubo virginianus*) from North America, purchased; a Great Eagle Owl (*Bubo maximus*) European, received in exchange.

OUR ASTRONOMICAL COLUMN.

COMET 1870 II.—This comet was discovered on August 28, by Coggia in Marseilles, and was last observed by Pechüle in Hamburg. During the period of its visibility it described a heliocentric arc of about 59°. On September 26 it approached its least distance from the earth, this being measured as 0·885 radii of the earth's orbit. In appearance the comet resembled a nebular mass with a perceptible nucleus; it varied, however, considerably, sometimes appearing without a nucleus, while at other times several nuclei were observed. Up to the present time the ephemeris obtained from the elements, computed by Gerst, represented very well the observed positions.

These elements were as follows:—

T = 1870 September 2·23393 Berlin Mean Time.

$$\left.\begin{array}{l} \pi = 7^\circ\ 53'\ 19''\!\cdot\!0 \\ \Omega = 12\ 56\ 22\cdot4 \\ i = 99\ 20\ 45\ 9 \end{array}\right\} 1870\cdot0$$

$$\log q = 0\cdot259288$$

Dr. Anton Schobloch has, however, undertaken the investigation of determining more thoroughly the elements of this comet. In this calculation he has included 311 observations, made at various observatories. The main figures in the computation will be found in *Astronomische Nachrichten* (No. 3383), together with the list of the observations and comparison stars used. The result shows, however, that there is no reason to depart from the assumption of a parabolic orbit. The final elements, as given below, differ only slightly from those obtained by Gerst. They are, as the following figures show:

Mean Equinox, 1870·0. Osculation, September 13·5, Berlin Mean Time.

T = 1870 September 2·2318232 Berlin Mean Time.

$$\left.\begin{array}{l} \pi = 7^\circ\ 53'\ 15''\!\cdot\!14 \\ \Omega = 12\ 56\ 18\cdot78 \\ i = 99\ 21\ \ 3\cdot90 \end{array}\right\} \text{Ecliptic}$$

$$\log q = 0\cdot2592768.$$

COMET GIACOBINI.—This comet is not a very bright object in the heavens, but as Prof. Kreutz appeals for more observations to enable an accurate determination of its period possible, we give the following ephemeris. The elements on which this is based are those obtained by Messrs. Perrotin and Giacobini from observations made on September 4, 12, and 27. A glance at the ephemeris, given in *Astr. Nach.* (No. 3384), shows that the southern declination of the comet commences, about November 3, to decrease.

Ephemeris for 12h. Berlin Mean Time.

1896.		R.A. app. h. m. s.	Decl. app. ° ′	log r.	log Δ	Br.
Oct. 29	...	19 36 26	−13 43·5	0·1616	0·1177	0 97
30	...	39 42	44·6			
31	...	42 58	45·4			
Nov. 1	...	46 15	46·0			
2	...	49 32	46·3	0·1620	0·1243	0·94
3	...	52 50	46·4			
4	...	56 8	46·2			
5	...	19 59 27	−13 45·7			

Planetary Notes. In the current number of *Astronomische Nachrichten* (No. 3384), the following information. which was telegraphed by Mr. Percival Lowell to Mr. J. Ritchie, jun., in Boston, is given :—

Oct. 4 Phison and Euphrates, Martian canals are double.

Oct. 5 Mercury and Venus rotate once on their axes in a revolution round the sun. Venus is not cloud covered but veiled in an atmosphere. Mercury is not.

Thus Mr. Lowell favours the view held by Schiaparelli and Perrotin regarding the length of the period of rotation of Venus. It may be remembered that this latter observer made a series of observations only last year to corroborate his previous work. He took up his position on a mountain (Mounier) 2741 metres high, where the atmosphere seemed all that could be desired for his observations. The result of his study was the same as that which he had formerly obtained. The appearance of the planet's terminator at different times suffered no variation, and the western limb, which could be well seen, resembled exactly the eastern as it was observed in 1890. Further, by watching carefully the dark markings at the different periods of time, the phenomenon of libration was noticed, a fact which considerably strengthens the hypothesis of a longer time of rotation than that favoured by several other observers, namely, about twenty-four hours.

At present the weight of evidence seems to favour the hypothesis of the long period, but it cannot be said as yet that the question is finally settled, for opinion is still divided.

PHYSIOLOGY AT THE BRITISH ASSOCIATION.

The formation of an independent section for Physiology and Experimental Pathology has been fully justified by the success of its second meeting at Liverpool. In scientific importance the communications compared favourably with those of Oxford, whilst the number of papers was so large that the business of the Section was with difficulty got through, although the sittings were extended to six days.

The proceedings opened on Thursday with a communication by Prof. McKendrick, on the application of the phonograph to the analysis of sounds. A new method of transcribing the phonographic records was demonstrated; the essential feature of this method consisted in an aluminium lever connected at one end with a special form of syphon recorder, and having the other shaped so as to accurately fit the grooves cut on the phonographic cylinder. A further feature of the transcribing apparatus was obtained by causing the phonographic cylinder to rotate with extreme slowness: by this means the vibrations of the syphon recorder could be transcribed on a continuous slip of paper, such as is employed in telegraphy, travelling at such speed that the phonogram events of 1″ were spread out over a distance of 10 feet on the record. An ingenious arrangement caused the continuous slip of paper to vibrate so as to obviate the necessity of the syphon recorder coming in contact with the paper, and thus diminishing to a minimum any error due to the friction of the writing pen. The transcribed tracings, magnified by the lever, represented the actual cylinder phonograms magnified 500 to 1000 times in amplitude. The tracings showed (1) that many musical instruments give a transcribed form which is absolutely characteristic: (2) that such characteristic form may be detected in very complicated phonograms—for instance, that caused by a band of instruments, including that which, when alone, gives the special form; (3) that when numerous sounds of different pitch follow one another in rapid succession. the ear recognises relative pitch when the transcribed curve shows that the special vibration for this has been repeated only ten times, *i.e.* when the sound has lasted a mere fraction of a second, presumably $\frac{1}{50}$″.

By means of a resonator comprising a microphone contact, the phonographic cylinder was made to produce oscillations which enabled the record to be transformed into variations of current intensity; the apparatus being much the same as that used by Hurthlé for obtaining electrical changes in correspondence with the sounds of the heart. The cylinder was arranged so that when driven slowly it communicated the record of its grooved inscription to a suitable tambour, and thus to the microphonic circuit. The variations in current intensity are, with suitable battery power, easily appreciated when conducted through the moistened hands, and give rise to specific series of sensations which can be appreciated by the deaf; it is thus possible that the rhythm, magnitude, and possibly the specific character of a phonogram may be rendered capable of being understood, apart from the sense of hearing.

Mr. R. J. Lloyd read a critical paper on the production of vowel sounds, and discussed the value of the phonographic evidence at present available for the analysis of such sounds.

Prof. Macallum, of Toronto, gave a short communication on a means of detecting the difference between organic and inorganic salts of iron. An absolutely pure solution of hæmatoxylin is turned bluish-black in the presence of inorganic salts of iron, but is not so affected by organic compounds. If the organic compounds of iron present in any tissue—spleen, liver, &c.—are changed by suitable treatment with acid, so as to produce inorganic iron salts, then the tissue stains very darkly with the hæmatoxylin, and is quite different in appearance to that which is produced by the same dye when no such inorganic salt is present. The views advanced by Bunge as to the introduction of iron into the system by means of organic, in preference to inorganic iron compounds, have resulted in the production of a very large number of so-called organic iron remedial agents. Prof. Macallum showed that a considerable number of these contained large quantities of the inorganic iron salts, which would be detected by the above method. The importance of possessing an easy and effectual means for differentiating between the two sets of iron compounds is by no means confined to the analysis of such remedial agents; a large number of physiological processes are intimately bound up with the transfer or the presence of iron, and the method of determining such an essential character of its chemical relations may be employed in many physiological investigations.

Dr. Marcet read a paper on types of human respiration. After a short introduction describing the graphic method employed in the investigation, the following different types were contrasted: (1) normal automatic breathing; (2) forced breathing; (3) breathing during exercise; (4) breathing whilst under the influence of a strong volitional effort. Forced breathing is characterised by a large increase in the volume of air taken in at each inspiration, its cessation being followed by the well-known pause, *i.e.* apnœa. Breathing during exercise gives tracings which are to be interpreted as indicating a similar increased amplitude in each inspiration; but on cessation of exercise there is no pause, the increased inspiratory effect being maintained, and only slowly returning to the normal. Breathing is influenced by any pronounced volitional effort, even when this effort is not carried out by obvious muscular activity. Thus a strong volitional effort towards a form of movement will cause an increase in the volume of inspired air. This increase may be seen superadded to that caused by actual exercise when both the exercise and the volitional effort are contemporaneous.

On Friday, Profs. Lorrain Smith and Westbrook gave an account of the febrile reaction produced in mice by inoculation with cultures of *Bacillus pyocyaneus*, *B. anthracis*, *murisepticus*, &c. Although these animals react to the inoculation, the febrile condition presents several remarkable characteristics as regards metabolism; thus the variations in respiratory interchange were not so marked as those due to food, or to alterations in the temperature of the surroundings in the normal animal. Similarly the elimination of nitrogen was not increased to the extent to which it was by food, although in mice the normal nitrogenous balance is one in which the diurnal intake and output is for the body weight extremely large. The febrile reaction in these animals appears not to be associated with a large increase in general metabolism; and this fact demonstrates the necessity for careful study of the conditions under which it occurs in separate groups of animals.

Prof. Thompson (Belfast) followed with a paper on the physiological effects of peptone when injected into the venous system. The injection of Witte's peptone dissolved in physiological sodium chloride solution produces well-known effects, the most prominent being the alteration in the coagulability of the blood and a vascular dilatation, causing a fall of blood pressure. The present investigation brought out some further points as to the production of these phenomena, which may be summarised as follows. (1) In doses over two centigrammes per kilo of body weight the peptone retards the susceptibility of blood to coagulation, but in weaker doses it actually favours such susceptibility; (2) even very small doses of ten milligrammes per kilo, if rapidly injected, can cause a fall of blood pressure; (3) the fall of blood pressure is due to the peripheral effect of the

substance upon the blood-vessels, and not to any interference with the central nervous system: (4) the vascular dilatation producing the fall is not confined to the splanchnic area; (5) the dilatation is brought about by lowering the excitability of the peripheral neuro-muscular mechanism of the arterioles; (6) this diminished excitability is in all probability chiefly limited to the nervous part of the above mechanism.

The experiments from which the above conclusions were deduced were carried out in the Sorbonne Laboratory, Paris, and consisted of observations of blood pressure under various conditions, such as section of the spinal cord, excitation of the cord after section, section of the splanchnic nerves, and excitation of the peripheral ends of these, and of the cord after their section. Facsimile photographic reproductions of the tracings were exhibited in support of the above statements.

A paper was read, by Dr. J. L. Bunch, on the nerves of the intestine, and the effects upon these of small doses of nicotine. The method of study was one in which a small portion of the intestine was suitably exposed and connected so as to record its movements. The following facts were brought out and illustrated by photographs of the tracings. (1) The stimulation of the peripheral end of the cut vagus nerve causes no motor effect as regards the portions of small intestine investigated. This is so not only with small doses of atropine to eliminate cardiac inhibition, but when the nerve is excited low down in the absence of atropine. (2) The excitation of the peripheral end of the cut splanchnic nerves may cause either contraction or dilatation of the portion of intestine, but does not produce simple inhibition of its movements.

These two facts thus seem to show, in opposition to the views previously held, that the vagus fibres play no part in the production of intestinal movements, and that the splanchnics contain augmentor and depressor fibres for the intestinal neuro-muscular mechanism.

Further researches as to the splanchnic fibres showed (*a*) that the nerve roots, the stimulation of which produce the splanchnic effects, are pre-eminently those between the eighth and thirteenth post-cervical nerves; (*b*) that the intravenous injection of small doses of nicotine can abolish the excitatory effects evoked by stimulation of the nerve roots, although effects may still be produced by excitation of the trunk of the splanchnic nerves; hence the nerve-cell station appears to be in the sympathetic ganglia.

Dr. Grünbaum followed with a communication on the effect of peritonitis on peristalsis. The peritonitis was produced by the injection of turpentine or other substances into the peritoneal cavity. The peristalsis was observed through the shaved abdominal wall, and in the opened cavity immersed in physiological salt solution at the body temperature. The peristalsis of both large and small intestine was increased for twenty-four hours after the injection; it then gradually diminished, and in four days resulted in complete paralysis, the large intestine being paralysed before the small intestine.

Dr. Pavy gave a communication on the glucoside constitution of proteid. He drew attention to the universal recognition of the importance of the glucoside in the vegetable kingdom, and to the fact that such bodies as salicin and amygdalin were known to admit of cleavage into nitrogenous and glucoside moieties. In the animal kingdom the mucin-like substance of bile admitted of a similar cleavage. In 1894 the author published a method for demonstrating a similar cleavage of proteid. This consisted in dissolving a tissue in potash, precipitating by alcohol, and treating the precipitate with sulphuric acid. The glucose produced, varied in amount according to the duration of the previous treatment with potash and the strength of the reagent, hence it could not be due to the conversion of the glycogen of the tissue by the acid; thus the action of potash is to split off from the proteid an amylose carbohydrate corresponding with the animal gum of Landwehr, which is converted by sulphuric acid into glucose. Dr. Pavy further stated his belief that a similar proteid cleavage may occur in the animal body resulting in the formation of glycogen, and thus of glucose, and that it is the excess of this disintegration which is the essential feature of diabetes; whilst if in the process of digestion a cleavage of similar character occurs, this fact must be one of extreme therapeutic importance in connection with the views held as to the dietetic treatment of diabetes.

Prof. Gotch communicated the results of experiments carried out by Mr. Burch and himself, which determined the time relations of the activity of a single nerve cell. The response of the electrical organ of *Malapterurus electricus* was shown to be the excitatory change in the nerve endings of the single axis cylinder which supplies it; the reflex response thus gives deductions as to the discharge of the single nerve cell from which this springs. The minimal central delay was found to be ·008″ to ·01″, of which time ·006 must be considered as delayed propagation in the central fine dendrites of both afferent fibre and efferent cell. The central rhythm is one which is very varied, but the extreme limit of frequency was shown to be twelve per second, and the average rate four per second; in all cases this rate was maintained for an extremely short period, each group of discharges comprising only from two to six members. The contrast between the reflex discharge in *Malapterurus* with its one nerve cell was contrasted with that of *Torpedo*, in which the very large number of cells is associated with a rapid central rhythm of from 30 to 100 per second.

On Saturday Prof. Minot (Harvard) showed a new form of microtome, prefacing the demonstration by remarks on the principles of microtome construction.

The new microtome could be adapted to cut either paraffin or celloidin sections, and its construction ensured precision by avoiding the following sources of error: (*a*) the bending of the knife, which is very heavy, of the chisel type, and securely clamped at both ends; (*b*) the yielding of the object to be cut, which is fixed on a wide supporting carrier; (*c*) the jumping of the sliding gear of the carrier; to effect this, the knife being immovable, the carrier gear is rendered as perfect as possible, and allows of displacement only in the direction of its slide, and the object secured upon the carriage by very rigid fastenings.

Additional advantages are secured by a simple accurate method of raising the object, a known amount, at each slide, and by a device for removing the alcohol moistening the knife and object so that it shall not fall upon the working gear.

The microtome has been placed on the market by Messrs. Bausch and Lamb of Rochester, New York; its probable cost being from twelve to fifteen pounds.

Prof. Waller gave a communication, illustrated by a large number of facsimile photographs, as to the conditions which modify the electrical response of an isolated nerve to stimulation.

The method of investigation was described: it consisted in stimulating the isolated nerve by a rapid series of induced currents for a very brief period, this stimulation being repeated at regular intervals; the electrical response thus evoked was indicated by means of a galvanometer suitably connected with the nerve, and arranged so that the deflections of the galvanometer needle should be photographed on a slowly moving plate. The nerve is practically submitted to a question-and-answer at regular short intervals, the question being constant, and the answer varying with the state of the nerve. Various chemical reagents alter the character of the response; and nerve records were exhibited showing (1) that chloroform is more toxic than ether; (2) that carbon dioxide is typically anæsthetic; (3) that nitrous oxide is inert; (4) that the basic is more effective than the acid moiety of such neutral salts as KBr, NaBr, and KCl; (5) that the response is modified by the action of various alkaloids, such as morphine, atropine, aconitine, veratrine, curarine, and digitaline.

Dr. Mann exhibited wax models of nerve-cells magnified one thousand times, and made from serial sections taken through the cell in different planes. The models showed the following points, in connection with the structure of the special cells thus portrayed. (1) The unipolar cells of spinal ganglia and multipolar cells of sympathetic ganglia are spherical or oval in the central parts of the ganglion, and flattened parallel to the surface at the periphery of the ganglion. (2) The distal process of the bipolar cells from the spinal ganglion of the guinea-pig is thinner than the proximal process. (3) The cells from Clarke's Column are frequently essentially bipolar, *i.e.* one axis cylinder passes upwards and another downwards, while the dendritic processes are comparatively very few and insignificant. (4) The motor cells in the spinal cord have wing-like processes. (5) In *Malapterurus* the cell body appears much broken up, because of the great development of the dendritic processes. Fritsch's idea of a "Bodenplatte," from which the axis cylinder is supposed to spring, is erroneous.

Dr. Buchanan exhibited a number of microphotographs illustrating cell granulations under normal and abnormal conditions. The evidence afforded by their study appeared to show that the granules of leucocytes are of definite formation, and are in no way analogous to secretion granules, and that whilst leucocytes,

under normal conditions, may be classified by the micro-chemical reaction of their granules into oxyphile and basophile groups, the distinction breaks down under abnormal conditions, since many leucocytes are then found exhibiting both oxyphile and basophile granulations at the same time.

Prof. Paul gave a demonstration of microphotographs illustrating some points in dental histology. The chief interest of the work was in regard to the formation of enamel. Whereas the dentine is regarded as a calcification of the intercellular matrix, the enamel is to be regarded as a calcification of cells, and thus tubular enamel is a negative picture of tubular dentine. Nasmyth's membrane was shown to be epithelial in structure, a fact admitting of easy demonstration after rapid decalcification by the phloro-glucin and nitric acid method; it was a remnant of the external layer of enamel epithelium.

Dr. E. Stevenson read a paper on the effect produced upon the eye movements by the destruction of the ear. The experiments were carried out in the dog, an interval elapsing between the lesion of the two sides. The destruction of the right ear caused impairment in the right eye movements, that of both a similar but more marked impairment of both eyes. The effect was great external strabismus, and the movements carried out by the muscles supplied by the third nerve showed a loss of power in these amounting to 75 per cent.

On Monday the President, Dr. Gaskell, gave his address on the origin of Vertebrates, the Section meeting in conjunction with that of Biology. At the President's request the address formed the basis for a discussion, in which several prominent biologists took part.

On Tuesday Prof. Haycraft gave an account of an investigation into photometry by means of the flicker method. The essential feature of this consists of a rotating disc with black and coloured segments, and the disappearance of flickering at any given speed of rotation is taken as the measurable point of luminosity. He also discussed Purkinjé's phenomenon, and showed experiments which proved that one essential factor in its production had been disregarded in previous work upon the subject, this being the persistent psycho-retinal effect of light surroundings; by placing the observer in a dark surrounding, the production of the phenomena is profoundly modified.

Prof. Allen read a paper on the physical basis of life, in which he advanced the following views. The vital phenomena are essentially related to change in the N atoms of nitrogenous compounds; they are accompanied by transfer of O, but this transfer is only brought about by the nitrogen; the nitrogen in the living molecule may be regarded as centrally situated, and in the pentad state; on death it is peripherally situated, and in the triad state.

Dr. Lazarus Barlow described the recent extension of his work upon osmosis, and particularly upon the rate at which this begins and is developed. The resultant initial osmotic pressure was shown to be one which, as produced by different substances, does not run parallel with the final osmotic pressures. Since in physiological processes such final osmotic pressures are out of the question, the initial effects are those which must be taken into account in the determination of such questions as the passage of substances through the living cells. A number of experiments, in which the thoracic outflow of lymph was determined before and after a rapid lowering of the specific gravity of the blood through bleeding, &c., showed no initial check in the rate of flow. The discrepancy between the initial effects produced by osmosis and those observed in the body, appeared to lead to the conclusion that osmosis plays but a small part in either the absorption of substances into the blood, or their outflow from this into the lymph channels.

Dr. Kanthack read a paper on the bacteria in food, in which he criticised the method of bacteriotogical analysis as applied to the determination of suspected food. The number of micro-organisms present in food obtained from very different sources was found to be practically the same, hence the quantitative method is valueless. As regards the qualitative method, the presence of *Bacterium coli* and of Proteus forms cannot be considered as conclusive evidence of fœcal or sewage contamination, since these two forms are apparently ubiquitous, and may be found in almost all food.

Dr. Sims Woodhead called attention to the desirability of the organisation of bacteriological research in connection with public health. He referred to the results obtained by the co-operation of public bodies with those directly concerned in the creation and management of scientific institutions. In London, the Metropolitan Asylums Board has approached the Laboratories of the Colleges of Surgeons and Physicians; in Manchester and Liverpool, the Public Health Committees have made arrangements with the Pathological Departments of Owens and of University College. The results have been of great utility to both sides, and these are examples of what can be achieved by spasmodic efforts. Could this co-operation be systematised and extended, the possibilities of benefit to the community would be enormous. The rapid investigation of matters immediately affecting public health would be the gain of the public, whilst the better equipment, and, above all, adequate maintenance of skilled scientific investigators, through the financial help of public bodies, would be the gain of science.

On Wednesday Dr. Hill, Master of Downing College, read a paper on the minute structure of the cerebellum, in which, among other points of interest, he brought forward evidence in favour of the view that the processes of the Purkinjé nerve cells could be traced into direct continuity with the peripheral arborisations of nerve fibres entering the grey substance from below.

Prof. Fokker read a paper on the basis of the bacteriological theory founded upon observations upon the fermentation of milk.

Dr. Copeman gave an account of experiments as to the action of glycerine upon the growth of bacteria. In this important communication the results of further experiments on the bacteriology of small-pox and vaccinia were brought forward, and thus the question of the purification and preservation of vaccine lymph was discussed. It was shown that whereas ordinary lymph is apt to contain numerous micro-organisms, no visible development of these takes place in lymph treated with 30 per cent. of glycerine. When a mixture of peptone broth and glycerine is inoculated with such organisms as *Streptococcus pyogenes*, *Staphylococcus pyogenes*, *aureus*, and *albus*, *Bacillus pyocyaneus*, *subtilis*, *Coli communis*, *diphtheriæ*, and *tuberculosis*, the microbes are all killed in less than a month by 30 to 40 per cent. of glycerine with the exception of *B. coli communis* and *subtilis*. *Bacillus coli communis*, unlike *B. typhosus*, resists the action of even 50 per cent. of glycerine for a considerable time in the cold, and this property may serve to differentiate between these varieties. Dr. Copeman's discovery that the monkey is susceptible to vaccination, has enabled him to ascertain that small-pox and vaccine material retain their efficacy when completely sterilised for extraneous microbes by the action of 40 per cent. glycerine. He has succeeded in obtaining cultures from such sterilised vaccine, and considers that the single small bacillus present in these may not improbably be the micro-organism of vaccinia.

Dr. Copeman was heartily congratulated by Sir Joseph Lister and Prof. Burdon-Sanderson on the important contribution he had made to preventive medicine.

Dr. Durham read a paper on some points in the mechanism of the reaction to peritoneal infections. He first referred to the work done by himself in conjunction with Prof. Grüber of Vienna, in relation to the alleged paucity of the hyaline and coarsely granular oxyphil leucocytes in the peritoneal liquid, the so-called leucopenia of Löwit. This paucity has been attributed to their destruction due, according to Metschnikoff, to the increased bactericidal power of the peritoneal fluid. The researches carried out at Vienna, and now described, showed that a large deposit of hyaline and the oxyphil cells is found deposited on the omentum, probably through the exceptionally active peristalsis which accompanies the early stages of peritonitis: with these are mixed the bacteria which were used for the local infection; and when these are of low virulence, they are ingested by the hyaline cells quite independent of any previous action of oxyphil cells. The passing away of the state of leucopenia is associated with the presence, in abnormal amount, of a polynuclear leucocyte or finely granular oxyphil cell.

The above is not the sole factor in the production of leucopenia; a second one of great importance was shown to be the flow of lymph along the lymphatics in connection with the peritoneal cavity. Both bacteria and cells are carried in great numbers along these channels.

The coarsely granular or megoxyphil cells are thus never abundant in the peritoneal cavity as free cells; on the other hand, the finely granular or microxyphil cells rapidly increase in number, especially during recovery from local infection, and synchronously with their presence the peritoneal liquid increases in bactericidal power.

Prof. Boyce brought forward the combined report of Prof.

Herdman and himself as to the bacteriology of the oyster. The research dealt with the following points:—

(1) The identification and differentiation of *Bacillus typhosus* and *B. coli communis*. This was determined by the difference (*a*) in fermentation; (*b*) indol production; (*c*) milk changes; (*d*) character of growth in potassic iodide potato gelatine; (*e*) behaviour in gelatine; (*f*) motility.

(2) The action of sea-water upon the growth of *B. typhosus*. There is no evidence of their multiplication, but the microbe can be detected under laboratory conditions for fourteen days after infection of the water.

(3) The bacteria present in the alimentary canal of the oyster. In cultures kept at 37° C. the microbes were almost entirely *B. coli*, and varieties of Proteus; but the deduction that the presence of these indicates sewage contamination could not, in the opinion of the authors, be made without special further research. The fresh oyster contains comparatively few bacteria and a small percentage of *B. coli*.

(4) The infection of the oyster with *Bacillus typhosus*. The research showed that this organism did not multiply in the oyster tissues even when these were thus infected; it further showed that on subjecting such infected oysters to a running stream of pure, clean sea-water, there was a complete disappearance of *B. typhosus* in from one to seven days.

Dr. Kohn added a chemical report upon the presence of iron and copper in the white and green varieties of oyster. It has been stated that the green colour of the gills of Marennes oysters is associated with an excess of iron in these. The author used an electrolytic method of analysis which, by decomposing the organic material, enables the minute quantities of metal present to be determined with considerable accuracy. The results showed that there was no excess of iron in the gills of green as compared with white oysters. Copper was found to be present in both the green and white varieties, but the slight excess in the gills of the former variety appears to be insufficient to account for their colour; a conclusion which is confirmed by Prof. Herdman's experiments as to the production of the green colour in oysters grown in very dilute saline solutions of iron salts.

Dr. Abram and Mr. Marsden read a paper on the detection of lead in organic fluids. The method employed consisted in a modification of that of von Jaksch. The fluid is mixed with ammonium oxalate in the proportion of 1 grm. to 150 cc. of fluid, and a strip of magnesium free from lead is immersed for twenty-four hours. The magnesium strip is discoloured if lead is present, and the following confirmatory tests may be applied: (*a*) warm strip with crystal of I, forming iodide of lead; (*b*) dissolve with HCl, and treat solution with sulphuretted hydrogen. The method is at bottom an electrolytic one, and gives results when lead is present in either water or urine in the proportion of 1 in 50,000. It is simple, and is applicable to all forms of organic fluid in which lead is suspected to exist.

CONFERENCE OF DELEGATES OF THE CORRESPONDING SOCIETIES.

THE first meeting of the Conference took place on September 17: Dr. Garson was in the chair.

The proceedings began with the reading of a short paper by Mr. George Abbott, general secretary of the South-Eastern Union of Scientific Societies. In this paper Mr. Abbott remarked that while local Natural History Societies had done much good work, yet that in many cases their efforts had been weak, irregular and desultory, the chief cause of failure having been, in his opinion, want of organisation. He thought that a step in the right direction had been taken by the Unions of Scientific Societies already existing, such as those of Yorkshire and the East of Scotland, but considered that the British Association did not sufficiently foster such unions, and that some plan was necessary to organise the local societies under the guidance of the Association, which should, through an organising secretary, help to bring these unions into being. He submitted the following plan for consideration:—

Districts.—The United Kingdom should be divided into fifteen or twenty districts, in each of which all Natural History Societies should be affiliated for mutual aid, counsel, and work. Existing unions should perhaps be imitated, at any rate not disturbed. Geographical lines should decide their size, which might vary in extent and be dependent, in some measure, on railway facilities. From time to time these areas might be subject to review, and necessary changes made.

Congress.—Each of such unions would have its annual congress attended by delegates and members from its affiliated societies. This would be held in a fresh town every year, with a new president, somewhat after the manner of the British Association itself. The congresses would probably take place in spring, but two should never be held on the same day.

These unions would render important help to local societies, would bring isolated workers together, assist schools, colleges, and technical institutes and museums, start new societies, and revive waning ones. Through these annual meetings local and petty jealousies would lessen or turn to friendly rivalries—each society trying to excel in real work, activity, and good science teaching.

Further, economy of labour would be accomplished by a precise demarcation of area for each local society. This would be understood as its sphere of work and influence; in this portion of country it would have a certain amount of responsibility in such matters as observation, research, and vigilance against encroachments on footpaths, commons, and wayside wastes.

These unions might also, through their Central Committees, bring about desirable improvements in publication, but it would perhaps not be desirable, in all cases, to go in for joint publication. In this, as in other matters connected with the unions, *co-operation and not uniformity* must be our aim.

Union Committees.—Each union would need a general secretary and a committee, all of whom should be intimately acquainted with methods of work and the best ambitions of local societies,

Corresponding Members.—This is another necessary development. Each local society should appoint in every village in its district a corresponding member with some distinctive title, and certain privileges and advantages.

The work asked of him would be to:

(1) Forward surplus natural history specimens to their Society's museum.

(2) Supply prompt information on the following subjects:—

(*a*) New geological sections.

(*b*) Details of wells, borings, springs, &c.

(*c*) Finds of geological and antiquarian interest.

(3) Answer such questions as the British Association or the local society may require.

(4) Keep an eye on historic buildings.

(5) Assist the Selborne Society in carrying out its objects.

In return he should be offered

(1) Assistance in naming specimens, and with the formation of school museums.

(2) Free admission to lectures and excursions.

(3) Copies of Transactions.

(4) Free use of the Society's library.

Mr. Abbott concluded with some remarks on the cost of these Unions. They would be maintained by means of small contributions from the affiliated societies. He did not attempt to estimate the expense of an organising secretary, but thought that, whatever it might be, the British Association would soon find itself amply repaid in the greatly increased efficiency of the local societies.

The Chairman (Dr. Garson) having invited discussion—

The Rev. E. P. Knubley gave the results of his experience of the Yorkshire Naturalists' Union during the twenty years of its existence. It was, he believed, the largest in the country, having 500 members and 2500 associates. It had thirty-six affiliated associations. Their work came under five sections, those of geology, botany, zoology, conchology and entomology. In addition they had research committees; such as a Boulder Committee, a Sea Coast Erosion Committee, and others. An annual meeting was held in one of the Yorkshire towns. Every effort was made to get each member to do some special work.

Mr. M. H. Mills then gave some account of the Federated Institution of Mining Engineers. Each of the societies composing it did its work independently, as before the existence of the Federation. The one difference was that there was now a single publication instead of many.

Mr. Montagu Browne described the constitution of the Leicester Literary and Philosophical Society. As to payments for printing, each section was usually self-supporting; but in

the case of unusually expensive papers, the parent society made a special grant, if necessary.

Mr. De Rance approved of Mr. Abbott's plan, and felt that without an organising secretary nothing in the way of federation would ever be accomplished.

Mr. W. T. Hindmarsh said, that while the Berwickshire Naturalists' Club had a large field of work, there was no other naturalists' club in it with which they could unite, though their boundaries included not only Berwickshire, but Northumberland outside Newcastle.

Prof. Merivale thought that it would be an excellent thing if the Naturalists' Societies could unite as the societies composing the Federated Institution of Mining Engineers had done.

Prof. Johnson said that they had a good example of a Union in Ireland. It comprised four clubs, one in Dublin, another in Belfast, a third in Cork, and a fourth in Limerick. These had one publication, which was common property, *The Irish Naturalist*.

Mr. Eli Sowerbutts felt that, while federation must generally commend itself to all, there were many delicate questions involved in it which made it difficult to come to a decision at that meeting.

After some discussion, it was decided that Mr. Montagu Browne, Prof. Johnson, the Rev. E. P. Knubley, Mr. Hindmarsh, Mr. W. W. Watts, Mr. O. W. Jeffs, the Rev. T. R. R. Stebbing, and Mr. G. Abbott should form a sub-committee to consider Mr. Abbott's propositions, and report to the Corresponding Societies Committee.

Meeting of the Sub-committee.

A meeting of the Sub-committee was held on Monday, September 21; the Rev. T. R. R. Stebbing in the chair. The following resolutions were agreed to:—

(1) That Mr. G. Abbott's paper on District Unions of Natural History Societies be distributed by the Committee of Delegates of the Corresponding Societies amongst *all* the Natural History Societies in the United Kingdom, with the request that their opinion on the feasibility of the plan advocated in the paper be communicated as early as possible to the Corresponding Societies Committee for its report to the next conference of delegates.

(2) That the formation of District Unions of Natural History Societies is highly desirable, and would be of general advantage.

(3) That the Committee of Delegates of Corresponding Societies be requested to take steps to encourage the formation of District Unions of Natural History Societies.

(4) That it should be distinctly understood that the formation of Unions would not in any way prevent the affiliation of individual Societies of such Unions to the British Association as at present.

The second Conference took place on September 22; Dr. Garson in the chair.

After some discussion, the report of the Sub-committee for the further consideration of Mr. Abbott's paper was received and adopted.[1]

The Chairman then called upon Prof. Flinders Petrie to read a short paper "On a Federal Staff for Local Museums."

The suggestions only affect a distribution of labour, and will rather economise than require extra expenditure.

In all local museums the main difficulty of the management is that there is neither money nor work enough for a highly trained and competent man. It is in any case impossible to get a universal genius who can deal with every class of object equally well, and hardly any local museum can afford to pay for a first-class curator on any one subject. These difficulties are entirely the result of a want of co-operation.

According to the report of the Committee in 1887, there are fifty-six first class, fifty-five second class, sixty-three third class, and thirty fourth class museums in the kingdom. Setting aside the last two classes as mostly too poor to pay except for mere caretaking, there are 111 in the other classes; and deducting a few of the first class museums as being fully provided, there are 100 museums, all of which endeavour to keep up to the mark by spending, perhaps, 30*l*. to 200*l*. a year on a curator.

The practical course would seem to be their union, in providing a federal staff, to circulate for all purposes requiring skilled knowledge; leaving the permanent attention to each place to devolve on a mere caretaker. If half of these first and second class museums combined in paying 30*l*. a year each, there would be enough to pay three first-rate men 500*l*. a year apiece, and each museum would have a week of attention in the year from a geologist, and the same from a zoologist and an archæologist.

The duties of such a staff would be to arrange and label the new specimens acquired in the past year, taking sometimes a day, or perhaps a fortnight, at one place; to advise on alterations and improvements; to recommend purchases required to fill up gaps; to note duplicates and promote exchanges between museums; and to deliver a lecture on the principal novelties of their own subject in the past year. Such visitants, if well selected, would probably be welcome guests at the houses of some of those interested in the museum in each place.

The effect at the country museums would be that three times in the year a visitant would arrive for one of the three sections, would work everything up to date, stir the local interests by advice and a lecture, stimulate the caretaker, and arrange routine work that could be carried out before the next year's visit, and yet would not cost more than having down three lecturers for the local institution or society, apart from this work.

To many, perhaps most, museums 30*l*. for skilled work, and 30*l*. or 40*l*. for a caretaker, would be an economy on their present expenditure, while they would get far better attention. Such a system could not be suddenly started; but if there were an official base for it, curators could interchange work according to their specialities, and as each museum post fell vacant it might be placed in commission among the best curators in that district, until by gradual selection the most competent men were attached to forty or fifty museums to be served in rotation. It is not impossible that the highest class of the local museums might be glad to subscribe, so as to get special attention on subjects outside of the studies of the present curators.

The Chairman having thanked Prof. Petrie and invited discussion—

Mr. W. E. Hoyle hoped that no action would be taken in this matter in such a way as to prevent co-operation with the Museums Association. Prof. Petrie's scheme seemed to him a most simple and practical one, and he hoped that those interested would confer with the officials of the Museums Association with regard to it. He thought the chief difficulty in carrying it out was the almost incredible inertia of Museum Committees.

Mr. M. H. Mills testified to the thoroughness with which such questions were discussed at meetings of the Museums Association.

Mr. G. Abbott supported Prof. Petrie's suggestions; and Mr. Richardson approved them, but thought the Committee of the Dorset County Museum was hardly in a position to incur the expense.

Prof. Johnson thought it would be a good thing if the Museums Association could become a Corresponding Society of the British Association, so that one or more of its chief officials could always be present at discussions of this kind. He would protest strongly against the suggestion that the curators of our museums should be converted into mere caretakers, as he thought the tendency should be of an opposite kind. He thought it would be better that our local societies should make a specialist of some kind their curator, and give him a chance of rising above the position he held at first.

Prof. Carr regretted that Prof. Petrie's paper had not been read before the Museums Association. Some time ago a sub-committee had been appointed by that Association to report upon a scheme resembling that of Prof. Petrie, but no definite result had been attained. Possibly if Prof. Petrie were now to bring this paper before the Museums Association, more important effects would be produced.

Prof. Petrie, in reply, said that this was to a great extent a money question. He did not, however, think that his suggestions necessarily involved additional expense. He thought that it was better that the money should be divided between the mere caretakers and the specialists, rather than that an attempt should be made to combine them by employing a man who could not be a specialist on all points. Indeed the curators, who were more than mere caretakers, would, through his plan, receive more than before, as they would be able to render service at a number of places, instead of being confined to one.

A vote of thanks to Prof. Petrie having been passed, the Chairman invited remarks from the representatives of the various Sections.

[1] In connection with this subject, it may be useful to remind the reader of Prof. Meldola's paper on "The Work of Local Societies" (Nature, vol. liv. p. 114, June 4, 1896).

Section C.

Mr. W. Watts invited the co-operation of the Corresponding Societies in the work of the Geological Photographs Committee and the Erratic Blocks Committee.

Mr. De Rance remarked that though the labours of the Underground Waters Committee had come to an end, he hoped the local societies would record carefully in their districts everything bearing upon that subject.

Section H.

Mr. Sidney Hartland asked for the co-operation of the Corresponding Societies in the work of the Ethnographical Survey Committee. Considerable progress had been made in the past year. There were no departments in which it was so important to have speedy information as those of dialect and folk-lore, as education, facilities for railway travelling, and industrial migrations were rapidly destroying local customs, dialects and traditions. Still, in some parts there had been little change, and if physical measurements were made and physical characteristics noted, in stationary districts, of persons belonging to the old families of the locality, much light might be thrown on the various races of the British Isles. He would be glad to furnish any delegates interested in the subject with copies of the Ethnographical Committee's schedules, or with any other help in his power.

Mr. John Gray (Buchan Field Club) described the work done in his district in noting the physical characteristics both of adults and of school children.

The Chairman remarked that Mr. Gray's society was doing very good work, and giving an illustration of what was required. As the information asked for by the Ethnographic Committee was of so many different kinds, he thought the local societies would be wise to form sub-committees, one dealing with physical measurements and characteristics, another with folk-lore, and so on. Then photographers were needed to illustrate both people and ancient monuments. Investigations of this kind would at once enrich the *Transactions* of a local society, and help the work of the British Association.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—The Walsingham Gold Medal for an essay or monograph on a botanical, geological, or zoological subject will be awarded next year. Competitors must be under the standing of M.A., and must send their essays to Prof. Newton, F.R.S., not later than October 9, 1897.

The General Board proposes to fix the stipend of the vacant Professorship of Surgery at £300, but hopes that after 1898 the state of the University finances may make it possible to raise this sum to £500 a year, tenable with a fellowship.

About 135 of the freshmen admitted this term propose to study natural science and medicine with a view to the B.A. and M.B. degrees.

Dr. Allbutt, F.R.S., is appointed an Elector to the chair of Pathology, and Dr. Hill to the chair of Anatomy, in the room of the late Sir G. M. Humphry.

The Examiners for the Natural Sciences Tripos 1897 are—W. N. Shaw, F.R.S., R. Meldola, F.R.S., Dr. A. Scott, A. Hutchinson, H. Woods, J. J. H. Teale, F.R.S., Dr. H. M. Ward, F.R.S., H. Wager, S. F. Harmer, F. Jeffrey Bell, F.R.S., A. C. Seward, J. J. Lister, Prof. A. M. Paterson, Dr. A. Hill, Dr. L. E. Shore, and Prof. W. D. Halliburton.

At the celebration of the 150th anniversary of Princeton University, on October 22, the degree of LL.D. was conferred upon Lord Kelvin and Prof. J. J. Thomson.

It is announced in *Science* that a laboratory built for the Massachusetts General Hospital, Boston, at a cost of over £4000, will soon be ready for use. The building includes well-fitted laboratories of chemistry, bacteriology and histology. It is hoped that an additional sum of £20,000 will be collected for an endowment.

Dr. Thos. Ewan, Chief Assistant in the Chemical Department of the Northern Polytechnic Institute, has been appointed Research Chemist to the British Aluminium Company in their works at Oldbury. He is succeeded at the Northern Polytechnic by Mr. H. Charles L. Bloxam, at present Chief Assistant in the Chemical Department of the Goldsmiths' Institute, New Cross.

The following Scholarships have been awarded in connection with the present session (1896-7) of the Central Technical College:—Clothworkers' Scholarship, £60 a year with free education for two years, L. P. Wilson; Mitchell Scholarship, £40 a year with free education for two years, R. S. Potter; Clothworkers' Technical Scholarship, £30 a year with free education for two years, E. W. Cook; David Salomons Scholarship, £50, E. W. Marchant; John Samuel Scholarship, £30, H. W. Hanbury; Institute's Scholarships, free education for three years, F. S. Miller, J. I. Hunter, F. W. Fawdry.

A general meeting of the members of the Convocation of the University of London was held on Tuesday. After a long discussion it was resolved:—"That this House earnestly desires the early establishment, in accordance with the expressed intentions of the founders of this University, of University professorships and lectureships in science and literature, together with such institutions as may tend to the encouragement of original study and research on the part of members of the University." It was further decided, on the motion of Mr. W. T. Lynn—"That it is desirable to make application to the Government for the provision of funds to establish a students' observatory in the neighbourhood of London for the instruction, primarily, of members of the University in practical astronomy, with the ultimate view of taking part in the progress of astronomical investigation."

So much money is being frittered away by Technical Education Committees as grants for instruction in such subjects as basket-making and hedging, that no apology is needed for again calling attention to the courses of science lectures which the Councils of University and King's Colleges, London, have arranged in conjunction with the Technical Education Board, to be held in the evenings and on Saturday mornings. These lectures are of a university type, being of the same standard as those which are given in the day-time. They are intended for those students who, being occupied in the day, are unable to obtain university instruction except in the evening: and they are given at considerably reduced fees. Among these courses may be mentioned: (1) An evening course on Advanced Chemistry, at University College, by Mr. C. F. Cross. The course will consist of fifteen lectures, given on Friday evenings, commencing on Friday, November 6: and the subject of the course is "Cellulose, the chemistry of vegetable fibres, and of their industrial preparations and uses." The fee for the whole course is £1 1*s.*, which, in the case of those who earn weekly wages, may be paid in two instalments. (2) A Saturday morning course for teachers, at University College, by Prof. Karl Pearson, on "Graphic Methods." The course deals mainly with the use of the drawing-board in elementary, geometrical, and mechanical teaching. The admission to this course is free for teachers. The following lectures have also been arranged by the Professors at the two colleges. In the evenings, Prof. Hudson Beare and Prof. Fleming are giving courses at University College on Mechanical Engineering and Electrical Engineering respectively; while at King's College, Prof. Robinson is holding a course on Civil Engineering, Prof. Banister Fletcher on Architecture, Prof. Adamson Experimental and Practical Physics, and Prof. Hudson on Pure Mathematics. The fee for each of these courses is £1 1s. On Saturday mornings Prof. Capper is holding a course, at King's College, on the Strength of Materials, to be followed in January by a course on the Theory of Machines. In January Prof. Fleming will also commence a course, at University College, on Electricity and Magnetism. The Saturday morning courses are free for teachers. We are glad to make these courses known, because we feel that their success would induce provincial Technical Education Committees to pay more attention to the higher branches of scientific instruction than most of them do at present.

SCIENTIFIC SERIALS.

American Journal of Science, October.—On the rate of condensation in the steam-jet, by A. de Forest Palmer. Photographs of a vertical steam-jet were obtained with the aid of sunlight. The invisible portion has the general shape of the inner mantle of a Bunsen flame, and its outline depends upon the pressure of the jet and the velocity with which the condensation travels towards the nozzle. The author finds that the separation surface of the invisible portion is sharply marked, and that it oscillates up and down. The demarcation is

probably due to the fact that the instantaneous heat of condensation is able to superheat the supersaturated steam as it arrives at the surface. The velocity of condensation increases markedly with the pressure; and since the initial velocity of the jet and the rate of decrease of its velocity in ascending also increase with the pressure, the amplitude of the oscillations decreases with it.—Abnormal hickory nuts, by F. H. Herrick. The author describes two hickory nuts of ordinary external appearance, but containing an endocarp strongly resembling an acorn, and supposed to be cases of hybridism between the oak and the hickory. The minute anatomy of their structure gives no direct evidence of hybridism, but the variation undoubtedly arose at the time of fertilisation, and is at present unexplained.—Separation and identification of potassium and sodium, by D. A. Kreider and J. E. Breckenridge. These metals may be effectively and delicately separated by converting their salts into perchlorates and precipitating the potassium with 97 per cent. alcohol. The sodium is then precipitated by blowing gaseous hydrochloric acid into the alcoholic filtrate.—A new method for reading deflections of galvanometers, by C. B. Rice. The method is based upon Gauss's mirror and scale method, but the telescope is replaced by a lens at a short distance from the mirror. The latter is perforated in the centre, and through the hole is seen a black arrow on a white ground placed at an equal distance beyond the mirror, which, being in the same plane as the reflected scale, serves as a pointer, and obviates the necessity of a telescope.—The action of ferric chloride on metallic gold, by P. C McIlhiney. Ferric chloride by itself, or hydrochloric acid in presence of air, have no action on gold. But a mixed solution of hydrochloric acid and ferric chloride dissolves gold when oxygen is present, the ferric chloride acting as a carrier.

American Journal of Mathematics, vol. xviii. No. 4, October.—Mr. E. H. Moore concludes his tactical memoranda i.-iii. with several more "whist-tournament arrangements," and gives a short list of the published literature of the subject.—In the Étude de Géométrie Cinématique réglée, M. René de Saussure proposes to establish a purely synthetical correspondence entre les points de la surface imaginaire et les droites de l'espace, de manière à obtenir une géométrie de l'espace réglé basée sur la géométrie supposée connue, de la surface. He discusses first the principles of the synthetic geometry of such a space, and then the kinematic geometry of the same space. He next gives applications of his theory. In this theory la ligne droite est prise comme élément d'espace, non-seulement au point de vue géométrique, mais aussi au point de vue mécanique; cette manière devoir conduit à la conception d'une *cinématique réglée*. La raison d'être de cette branche de la cinématique provient du fait que le déplacement le plus général d'un corps solide est une torsion et l'effort le plus général exercé sur un solide est ce que Plücker appelle un dyname et Ball un torseur (wrench); car l'effort que développe un dyname ou un torseur s'exerce sur une droite de même qu'une force s'exerce sur un point, puisque le vectangle est à la droite ce que le vecteur est au point.—The volume closes with a paper by Goursat, entitled "Sur les équations linéaires et la méthode de Laplace." In it the author develops, at some length, a recent note which he presented to the Academy of Sciences (*Comptes rendus*, t. cxxii., January 27, 1896).

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 19.—M. A. Chatin in the chair.—The President announced the death of M. Trécul, Member of the Botanical Section, on October 15.—New researches relating to the decomposition of sugars, under the influence of acids, and especially with the production of carbonic acid, by MM. Berthelot and G. André. The experiments were partly conducted in sealed tubes at 100°, partly in open flasks, at the boiling point. Estimations were made of carbonic acid, carbon monoxide, formic acid, levulic acid, humic acid, and unattacked glucose. Besides glucose, experiments were carried out with levulose, galactose, and maltose. The principal reaction appears to be the formation of humic acid; carbonic acid is also formed in not inconsiderable quantity.—Determination of the magnetic elements at sea. Applications of the observations made by M. Schwerer on the *Dubourdieu*, by M. E. Guyon. Since the formulæ developed by Archibald Smith and by Börgen for correcting the readings made at sea, were worked out for ships into the construction of which comparatively little iron entered, it became necessary to make a fresh study of the corrections to be applied to readings taken upon warships as built at present. In the method here indicated all the constants necessary for the corrections for each kind of observation (declination, inclination, and total force) are deduced exclusively from observations of the same nature.—On the work carried out at the Observatory of Mount Blanc in 1896, by M. J. Janssen. The work has been considerably impeded by the bad weather prevailing, the actinometric observations being especially interfered with. The large telescope (33 cm. diameter) has been successfully mounted, and the observations on the values of the acceleration due to gravity at different points on the mountain have been continued.—Study of the digestibility of cocoa-butter and ordinary butter, by MM. Bourot and F. Jean. Comparative experiments carried out with the same person showed that 95·8 per cent. of ordinary butter is digested, and 98 per cent. of cocoa-butter. An abnormally large quantity of fat in the food causes less disturbance if the fat is cocoa-butter than if it is present as ordinary butter.—Some colour reactions of brucine: detection of nitrous acid in presence of sulphites, by M. P. Pichard. The red colouration produced in an acid solution of brucine by a nitrite is capable of showing one part of nitrous acid in 640,000 parts of water, and is more sensitive in the presence of sulphites and hyposulphites than the tests proposed by Griess, Tromsdorff, and Piccini.—General principles relating to the physics of space, by M. J. Poulin.—Tempests and cyclones, by M. A. de Langrée.—Note on aërial navigation, by M. Caravanier.—On some peculiarities of solubility curves, by M. H. Le Chatelier. Some experiments on the melting points of some double salts and alloys, showed that in the neighbourhood of the composition corresponding to a definite combination ($SnCu_3$, $SbCu_2$, Al_2Cu, &c.), the curve showed a maximum temperature in the form of an angular point, which did not necessarily correspond exactly to the point of definite composition. The theoretical discussion elucidates the reason for this peculiarity.—Influence of pressure in the changes of state of a body, by M. A. Ponsot.—On the property of discharging electrified conductors, produced in gases by the X-rays and by electric sparks, by M. E. Villari, It is shown that a gas confined in a tube, and exposed to the X-rays, acquires rapidly the power of discharging an electrified disc, and keeps this property for some time. The passage of a series of sparks from a coil strengthened by a condenser, confers the same property upon a gas.—On the action of the silent discharge upon the property of gases of discharging electrified conductors, by M. E. Villari. Gases subjected to the action of a series of sparks acquire an increased conductivity for heat. The silent discharge is not able to put the gas into the condition in which it can discharge an electrified body, but if a gas which has been subjected to X-rays, and which therefore is in this condition, is subjected to the silent discharge, it is no longer able to affect a charged gold-leaf electroscope.—Succession of the atomic weights of the elements, by M. Delauney. An attempt to classify the elements according as their atomic weights are expressed by: $4n$, $4n + 3$, $4n + 2$, or $4n + 1$.—Phosphopalladic ethers. Ammoniacal derivatives of phosphopalladous and phosphopalladic ethers, by M. Finck.—Law of the establishment and persistence of the luminous sensation, deduced from new experiments upon rotating discs, by M. Charles Henry.—On the jaws in insects, by M. Joannes Chatin.—On the habits of *Evania Desjardinsii*, by M. E. Bordage.—New observations on the bacteria of the potato, by M. E. Roze.—Some remarks on the kerosine shale of New South Wales, by M. C. E. Bertrand.—On the micro-granulites of the Ferret valley, by MM. L. Duparc and F. Pearce.—On the mode of formation of the Pyrenees, by M. P. W. Stuart-Menteath.—Contribution to the theory of the movements of storms, by M. J. Vinot.

AMSTERDAM.

Royal Academy of Sciences, September 26.—Prof. Stokvis in the chair.—Prof. Korteweg, who, as delegate of the Dutch Government, attended the Royal Society conference on the desirability of preparing a catalogue of scientific works, spoke of this conference, and entered into some details concerning its purpose, the nature of the resolutions passed, the task of the national bureaux, and the arrangement of the subject-index. Prof. Haga exhibited two negatives which prove the existence of different kinds of X-rays, a conclusion also arrived at by

other investigators. At a high degree of rarefaction in the vacuum-tubes the penetrating power of the rays through flesh and bone is very different, so that the outlines of the bones are very distinct, whilst, when the rarefaction is less great, these two bodies transmit the rays in about the same degree.—Prof. Kamerlingh Onnes made, on behalf of Dr. L. H. Siertsema, a communication on measurements of magnetic rotations, carried out in the Leyden Physical Laboratory. With the apparatus described in former communications determinations have been made of the absolute rotation constant of water, with the object of controlling the reduction-factor, with which the rotation determination has been reduced to an absolute measure. The result found is 0·01302′ at 13°·4, which corresponds very well with the constants found by Arons and by Rodger and Watson. A second communication again gave the results for gases, as they have undergone a slight alteration, owing to a necessary correction in the manometer readings.—Prof. Kamerlingh Onnes also communicated Dr. Zeeman's measurements on the variation of the absorption of electrical waves with the wave-length and the concentration of the electrolyte. The results, which hold good between limits given in detail in the paper, are: the coefficient of absorption changes as the square root of the conductivity of the solution, and it does not change, if conductivity and wave-length vary in the same ratio.—Prof. Engelmann communicated the results of an investigation into reflexes of the auricle of the heart, made by Mr. J. J. L. Muskens in the Utrecht Physiological Laboratory, by experimenting upon frogs' hearts.

DIARY OF SOCIETIES.

FRIDAY, October 30.

Physical Society, at 5.—Special Meeting, after which, at an Ordinary Meeting—A Satisfactory Method of measuring Electrolytic Conductivity by means of Continuous Currents: Prof. W. Stroud and J. B. Henderson.—A Telemetrical Spherometer and Focometer: Prof. W. Stroud.—An Experimental Exhibition: R. Appleyard.

SATURDAY, October 31.

Essex Field Club, at 6.30 (at Chingford)—Short Report, by the Curator, on the first year's work at the Epping Forest Museum.—Our Forest Trees, and How they should be represented in the Museum: Prof. G. S. Boulger.—Notes on the Conference of Delegates of the Corresponding Societies of the British Association, Liverpool, 1896: T. V. Holmes.

MONDAY, November 2.

Society of Chemical Industry, at 8.—The Production of Inoculating Materials for Use in Agriculture (Nitragin): Dr. J. A. Voelcker.—The Smelting and Refining of Cyanide Bullion: Arthur Caldecott.

TUESDAY, November 3.

Institution of Civil Engineers, at 8.—Address by J. Wolfe Barry, C.B., F.R.S., the President.

WEDNESDAY, November 4.

Geological Society, at 8.—Additional Note on the Sections near the Summit of the Furka Pass (Switzerland): T. G. Bonney, F.R.S.—Geological and Petrographical Studies of the Sudbury Nickel District (Canada): T. L. Walker (communicated by J. J. H. Teall, F.R.S.).—On the Distribution in Space of the Accessory Shocks of the Great Japanese Earthquake of 1891.

Entomological Society, at 8.

Institution of Mechanical Engineers, at 7.30.—Research Committee on the Value of the Steam Jacket; Experiment on a Locomotive Engine: Prof. T. Hudson Beare and Bryan Donkin.—Transmission of Heat from Surface Condensation through Metal Cylinders: Lieut.-Colonel English and Bryan Donkin.

Society of Public Analysts, at 8.—Note on Ginger: Thos. B. Blunt.—The Determination of Stearic Acid in Fats: Otto Hehner and C. A. Mitchell.—Further Note on Lead in Canadian Cheese: F. Wallis Stoddart.

THURSDAY, November 5.

Chemical Society, at 8.—The Constitution of Nitrogen Iodide: Dr. F. D. Chattaway.—Note on the Solution and Diffusion of certain Metals in Mercury: Prof. Roberts-Austen, C.B., F.R.S.—Compounds of Metallic Hydroxides with Iodine: J. Rettie.—The Economical Preparation of Hydroxylamine Sulphate; The Reduction of Nitrosulphates; and Amidosulphonic Acid: Dr. E. Divers, F.R.S., and Dr. T. Haga.—The Molecular Conductivity of Amidosulphonic Acid: Joji Sakurai.—Physiological Action of Amidosulphonic Acid: Dr. Oscar Loew.—Imidosulphonates, Part II.: Dr. E. Divers, F.R.S., and Dr. T. Haga.—How Mercurous and Mercuric Salts change into each other: Seihachi Hada.—The Effect of Heat on Aqueous Solutions of Chrome Alum: Margaret D. Dougal.—The Saponification of Ethylic Dicarboxyl Glutaconate: Dr. H. W. Bolam. The Periodic Law: R. M. Deeley. The Colouring Matters occurring in British Plants: A. G. Perkin.—Carbohydrates of Cereal Straws: C. F. Cross, E. J. Bevan, and Claude Smith.

Linnean Society, at 8.—Mediterranean Bryozoa: A. W. Waters.—On some New Species of Crassula from South Africa: Dr. S. Schönland.—Holothurians of New Zealand: A. H. Dendy.

Institution of Mechanical Engineers, at 7.30.—Breakdowns of Stationary Steam-Engines: Michael Longridge.

FRIDAY, November 6.

Geologists' Association, at 8.—Conversazione and Exhibition of Specimens.

BOOKS, PAMPHLET, and SERIALS RECEIVED.

Books.—General Report on the Operations of the Survey of India Department, 1894-95 (Calcutta).—Practical Work in Physics; W. G. Woolcombe. Part 3, Light and Sound (Oxford, Clarendon Press).—Firth College, Sheffield, Sheffield School of Medicine, Calendar, 1896-97 (Sheffield).—Elements of Mechanics: Dr. T. W. Wright (Spon).—A History of Gardening in England: Hon. Alicia Amherst, 2nd edition (Quaritch).—Les Galets Coloriés du Mas d'Azil: Ed. Piette (Paris, Masson).—The Method of Darwin: F. Cramer (Chicago, McClurg).—Les Accumulateurs Electriques: F. Loppé (Paris, Gauthier-Villars).—Annalen der Kaiserlichen Universitäts-Sternwarte in Strassburg, i. Band (Karlsruhe).—Journal of the Right Hon. Sir Joseph Banks, edited by Sir J. D. Hooker (Macmillan).—Index Operum Leonardi Euleri: J. G. Hagen (Berolini, Dames).—Experience: Rev. W. Richmond (Sonnenschein).—A New Course of Experimental Chemistry, revised edition (Murby).—The Life and Letters of George John Romanes, new edition (Longmans).—Report on the Geodetic Survey of South Africa, executed by Lieut.-Colonel Morris in 1883-1892 (Cape Town, Richards).—Model Drawing and Sharing from Casts: T. C. Barfield (Chapman).—Cheese and Cheese-making, &c.: J. Long and J. Benson (Chapman).—An Introduction to Human Physiology: Dr. D. J. Waller, third edition (Longmans).—Die Mineralogie des Harzes, and Atlas: Dr. O. Luedecke (Berlin, Gebrüder Borntraeger).

Pamphlet.—Sociedad Cientifica Argentina. Semillas y Frutos: Prof. A. Gallardo (Buenos Aires).

Serials.—Journal of the Chemical Society, October (Gurney).—Record of Technical and Secondary Education, October (Macmillan).—Quarterly Review, October (Murray).—Psychologische Arbeiten, i. Band, 4 Heft (Leipzig, Engelmann).—L'Anthropologie, tome vii. No. 4 (Paris, Masson).—American Naturalist, October (Philadelphia).—Journal of the Franklin Institute, October (Philadelphia).—Zeitschrift für Physikalische Chemie, xxi. Band, 1 Heft (Leipzig).—The Bachelor of Arts, October (New York).—Journal of Anatomy and Physiology, October (Griffin).—Astrophysical Journal, October (Chicago).—Brain, Parts 74 and 75 (Macmillan).—Royal Natural History, Part 36 (Warne).—Bibliotheca Geographica, Band 2, Jahrg. 1893 (Berlin, Kuhl).—Proceedings of the Royal Society, Edinburgh, Session 1895-96, Vol. xxi. No. 2, Pp. 65 to 160 (Edinburgh).—Journal of the Asiatic Society of Bengal, Vol. lxv. Part 2, No. 2 (Calcutta).—Sunday Magazine, November (Isbister).—Good Words, November (Isbister).—Himmel und Erde, November (Berlin, Paetel).—American Journal of Psychology, Vol. viii. No. 1 (Worcester, Mass.).

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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

No. 1384, Vol. 54.] THURSDAY, MAY 7, 1896. [Price Sixpence.

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ROYAL INSTITUTION OF GREAT BRITAIN.

ALBEMARLE STREET, PICCADILLY, W.

Tuesday next (May 26), at Three o'clock, Professor T. G. Bonney, D.Sc., LL.D., F.R.S.—First of Two Lectures on "The Building and Sculpture of Western Europe." (The Tyndall Lectures.) Half-a-Guinea the Course.

Thursday (May 28), at Three o'clock, Robert Munro, Esq., M.D., M.A. First of Two Lectures on "Lake Dwellings." Half-a-Guinea.

Saturday (May 30), at Three o'clock, Dr. E. A. Wallis Budge, M.A., Litt.D., F.S.A., Keeper of the Egyptian and Assyrian Antiquities, British Museum.—First of Two Lectures on "The Moral and Religious Literature of Ancient Egypt." Half-a-Guinea.

CITY AND GUILDS OF LONDON INSTITUTE.

SESSION 1896-97.

The Courses of Instruction in Engineering and Chemistry at the Institute's Colleges commence in October, and cover a period of two to three years. The Matriculation Examination of the Central Technical College will be held on September 21 to 24, and the Entrance Examination of the Day Department of the Technical College, Finsbury, on September 22.

CITY AND GUILDS CENTRAL TECHNICAL COLLEGE

(Exhibition Road, S.W.), a College for higher Technical Instruction for Students not under 16 years of age, preparing to become Civil, Mechanical or Electrical Engineers, Chemical and other Manufacturers, and Teachers.

The Matriculation Examination will be held on September 21 to 24, and the new Session will commence on October 1st.

Professors:—O. Henrici, LL.D., F.R.S. (Mathematics), W. C. Unwin, F.R.S., M.I.C.E. (Civil and Mechanical Engineering), W. E. Ayrton, F.R.S. (Physics and Electrical Engineering), H. E. Armstrong, Ph.D., F.R.S. (Chemistry).

CITY AND GUILDS TECHNICAL COLLEGE, FINSBURY

(Leonard Street, City Road, E.C.). The DAY DEPARTMENT provides Courses of Intermediate Instruction for Students not under 14 years of age, preparing to enter Mechanical or Electrical Engineering and Chemical Industries.

The Entrance Examination will be held on September 22, and the new Session will commence on October 6.

Professors:—S. P. Thompson, D.Sc., F.R.S. (Electrical Engineering), J. Perry, D.Sc., F.R.S. (Mechanical Engineering), R. Meldola, F.R.S. (Chemistry). JOHN WATNEY, Hon. Secretary.

City and Guilds of London Institute,
Gresham College, Basinghall Street, E.C.

CITY AND GUILDS OF LONDON INSTITUTE for the ADVANCEMENT of TECHNICAL EDUCATION.

The Committee of the Institute are prepared to appoint a PROFESSOR of MECHANICAL ENGINEERING and APPLIED MATHEMATICS at the Technical College, Finsbury. The Professor, besides giving Lectures and holding Day and Evening Classes on the Subjects of his Professorship, will be required to superintend the Workshops and to give Instruction in Machine Designing and Drawing. The Professor will be expected to devote to the work of the Institute the whole of his time available for teaching, and shall not undertake any other educational work; but he will be permitted to undertake consulting professional work which will not interfere with the full discharge of his Professorial duties, subject to such regulations as shall be approved by the Committee. The Salary offered is £600 per Annum.

The Appointment will date from September 29, 1896.

Applications for the Appointment, with Testimonials or References, addressed to the Honorary Secretary, City and Guilds of London Institute, Gresham College, E.C., to be sent in not later than June 8.

UNIVERSITY OF ABERDEEN.

ANDERSON LECTURESHIP IN COMPARATIVE PSYCHOLOGY
(Ord. No. 105).

The University Court will proceed early in July to the Election of a LECTURER on COMPARATIVE PSYCHOLOGY.

The Lecturer will be required to deliver an Honours Course of not fewer than 50 Lectures, extending over not more than Six Months.

The Lectureship will be tenable for Five Years, and the Lecturer will be eligible for re-election. He will be expected to enter on his duties next October.

The Lecturer will receive the free income of Dr. William Anderson's Bequest, amounting at present to about £350 per annum.

Applications, with such Testimonials as the Candidate may desire to offer, must be lodged, on or before July 4, ensuing, with Robert Walker, Esq., M.A., Secretary of the Court.

University of Aberdeen, May 14, 1896.

FIRTH COLLEGE, SHEFFIELD.

The Council of Firth College intends to appoint a DEMONSTRATOR and ASSISTANT LECTURER in BIOLOGY, specially qualified in Botany. Stipend, £120.

Candidates must send in their Applications before June 10.

Further Particulars can be obtained from Ensor Drury, Registrar.

NORTHERN POLYTECHNIC INSTITUTE.

The GOVERNORS invite Applications for the following Appointments:—

HEAD of the DEPARTMENT of ENGINEERING; commencing Salary, £250 per Annum.

HEAD of the DEPARTMENT of PHYSICS and ELECTRICAL ENGINEERING; commencing Salary, £250 per Annum.

CHIEF ASSISTANT in the DEPARTMENT of CHEMISTRY; commencing Salary, £180 per Annum.

The Appointments will date from September 29, 1896, but the Candidates appointed will be expected in the meantime to consult with the Principal as to the Equipment and Organisation of their Department.

Conditions of Appointment and Forms of Application may be obtained from the Secretary, at the Institute, Holloway Road, London, N.

Applications, accompanied by Copies of recent Testimonials and the names of Three Referees, to be sent in to the Principal, not later than June 1, 1896. E. GRIFFITHS, Secretary.

COUNTY BOROUGH OF SALFORD.

MUNICIPAL TECHNICAL INSTITUTE.

The following Appointments are about to be made, viz.:—

CHIEF LECTURER in CHEMISTRY, Salary £200
" " DYEING, " £150
ART MASTER ... ... " £220

Forms of Application and Particulars of Duties may be obtained upon application to the Secretary, at the Institute, Peel Park, Salford.

By Order,
Town Hall, Salford, May 6, 1896. SAML. BROWN, Town Clerk.

The HEAD MASTER of the INTERMEDIATE SCHOOL, BUILTH,

will receive applications for position of MISTRESS, to commence duties July 1. Music, vocal and instrumental, essential. Salary, £100. Applications, stating age, qualifications, and experience, to be sent in, not later than May 29, to Head Master, Intermediate School, Builth.

YELVERTON COLLEGE.

HIGH-CLASS SCHOOL FOR GIRLS.

For Prospectus, Fees, and Referees, apply to the Principal,
Miss HEATH, Yelverton, S. Devon.

FOR SALE.

Complete Set of the Publications of the Palæontographical Society—50 Volumes in good condition, numerous Plates, mostly uncut, Price £25, or offers. Also Complete Set of Publications of Egypt Exploration Fund—12 Large Books with Plates, perfect condition; also Papyri and 4 Reports. Price £10, or offers. Also Complete Set of the Publications of the Palestine Exploration Fund, Plates, Maps, Quarterly Statements, and about 20 Books. What offers? Also Complete Set of Publications of the Royal Asiatic Society's Journal—33 Vols. bound, remainder unbound. What offers? Further Particulars will be furnished if required.—Apply Bewley & Gossage, Solicitors, 9c, Queen Insurance Buildings, Dale Street, Liverpool.

CHEAP SETS OF IMPORTANT JOURNALS.

In good condition, and sent Carriage Free in Great Britain.

NATURE. Complete Set, from the commencement in 1869 to 1893, 48 vols., orig. cloth, uniform. Fine set. Scarce. £12.

TRANSACTIONS OF THE BOTANICAL SOCIETY of Edinburgh. Complete Set to 1889, 17 vols. in 14, 8vo, half calf. Scarce. £7 7s.

TRANSACTIONS OF THE ROYAL SOCIETY of Edinburgh. Complete Set from vol. i. 1798 to 1890, 36 vols. 4to, half-calf. Rare. £45.

PHILOSOPHICAL MAGAZINE (The). Complete Set from the commencement in 1798 to vol. xx., Fifth Series, 1885 (exc. 1 vol. 1826 and 7 Nos.), 185 vols., half-bound, &c. Very scarce. £64.

WILLIAM F. CLAY, 18 Teviot Place, Edinburgh.

X-RAYS.

FLUORESCENT SCREENS, 10s. 6d. Post-free. Most carefully prepared. Every Screen tested and guaranteed. The bones of the body can be easily and rapidly examined with the greatest clearness and precision through these excellent Screens. A Stereoscopic Dark Box fitted to the Screens, 6s. extra.—Address H. Lees, Castletown, Isle of Man.

TOPAZ.—Wanted from 80 to 100 Siberian

Crystals, to add to our fine Collection. Perfect Crystals, standing 4 to 9 inches high, and blue blending into wine colour preferred. Address, Museum House, Caversham Road, N.W.

PAUL

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44 Hatton Garden, London.
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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

No. 1387, Vol. 54.] THURSDAY, MAY 28, 1896. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1388, VOL. 54.] THURSDAY, JUNE 4, 1896. [PRICE SIXPENCE.

Registered as a Newspaper at the General Post Office.]

NOTICE.

NATURE

Of Thursday next, June 11, will contain the

INDEX

TO

Volume LIII. Its price will be One Shilling.

Advertisements intended for insertion in this Number should reach the Publishers by the morning of Wednesday, June 10.

"NATURE" OFFICE,
29 BEDFORD STREET, STRAND, W.C.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE,

BURLINGTON HOUSE, LONDON, W.

The NEXT ANNUAL MEETING of the ASSOCIATION will be held at LIVERPOOL, commencing on WEDNESDAY, SEPTEMBER 16.

President-Elect:
Sir JOSEPH LISTER, Bart., D.C.L., LL.D., President of the Royal Society.

G. GRIFFITH, Assistant General Secretary.

McGILL UNIVERSITY, MONTREAL, CANADA.

The Governors of McGill University are prepared to receive Applications for the following posts:—

A PROFESSORSHIP of ARCHITECTURE.
A PROFESSORSHIP of MINING AND METALLURGY.
AN ASSISTANT PROFESSORSHIP of CIVIL ENGINEERING.
AN ASSISTANT PROFESSORSHIP of DESCRIPTIVE GEOMETRY and FREEHAND DRAWING.

The nature of the work is fully described on pages 18 to 27 of the University Announcement, copies of which may be obtained on application to the Editor of Nature, or the Editor of *Engineering*. For further information apply to the Secretary, McGill College, Montreal.

In the case of the Professorship of Mining, and of the Assistant Professorship of Civil Engineering, experience in Laboratory work is essential. The Assistant Professor of Civil Engineering should also have a thorough knowledge of Hydraulics.

Candidates for the Assistant Professorship of Descriptive Geometry and Freehand Drawing should have a knowledge of Architectural Drawing, as the Assistant Professor of this subject will be expected to give assistance to the Professor of Architecture.

Candidates for any of the above Appointments must send their names to the undersigned, together with a statement of their age, previous career, and qualifications, with such Testimonials as they may think desirable, not later than July 14.

J. W. BRAKENRIDGE,
Acting Secretary, McGill College.

BALLIOL COLLEGE, CHRIST CHURCH, AND TRINITY COLLEGE, OXFORD.

NATURAL SCIENCE SCHOLARSHIPS AND EXHIBITIONS.

A Combined Examination for Natural Science Scholarships and Exhibitions will be held by the above Colleges, beginning on TUESDAY, NOVEMBER 17, 1896.

Three Scholarships and two Exhibitions will be offered, the Scholarships being worth £80 a year.

The subjects for Examination will be Physics, Chemistry, and Biology, but Candidates will not be expected to offer themselves in more than two of these.

Particulars may be obtained by application to

A. VERNON HARCOURT.

Christ Church, Oxford.

BEDFORD COLLEGE (LONDON)

FOR WOMEN,
8 and 9 YORK PLACE, BAKER STREET, W.

ENTRANCE SCHOLARSHIPS.

One Arnott Scholarship in Science, Annual Value £48, and one Reid Scholarship in Arts, Annual Value Thirty Guineas, each tenable for Three Years, will be awarded on the result of the Examination, to be held at the College on June 23 and 24.

Names to be sent in to the Principal, not later than June 15.

LUCY J. RUSSELL Honorary Secretary

BEDFORD COLLEGE (LONDON)

FOR WOMEN,
8 and 9 YORK PLACE, BAKER STREET, W.

The Professorship in Hygiene at this College will be vacant at the end of this Session. Applications, together with Copies of Testimonials, must be sent in by June 16, to the Honorary Secretary at the College, from whom all information may be obtained.

FIRTH COLLEGE, SHEFFIELD.

The Council of Firth College intends to appoint a DEMONSTRATOR and ASSISTANT LECTURER in BIOLOGY, specially qualified in Botany. Stipend, £120.

Candidates must send in their Applications before June 10.

Further Particulars can be obtained from Ensor Drury, Registrar.

WANTED, at the CAMBORNE MINING

SCHOOL, an ASSISTANT TEACHER capable of teaching CHEMISTRY, and taking charge of a Laboratory. Preference will be given to one qualified to teach Metallurgy, Mineralogy, Geology, or Mathematics. Apply immediately, Secretary.

YELVERTON COLLEGE.

HIGH-CLASS SCHOOL FOR GIRLS.

For Prospectus, Fees, and Referees, apply to the Principal, Miss HEATH, Yelverton, S. Devon.

OPTICAL & SCIENTIFIC INSTRUMENTS.

Spectrometers, Spectroscopes, Goniometers, Cathetometers, Optica Benches, &c., &c. Instruments for special purposes constructed to Clients own designs. *Price List on application.*

W. WILSON (formerly Foreman at Messrs. Elliott Bros.), 56 Crogsland Road, Chalk Farm, London, N.W.

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With this SCREEN and B. and M.'s TUBE, good Photographs of the hand are taken in *two seconds* with a five-inch Coil and proportionately with smaller Coils. Prices: for Half-Plate, 5s.; Whole Plate, 8s. 6d., Post Free.

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BRADY & MARTIN,

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NEWCASTLE-ON-TYNE.

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FOR EXPERIMENTS WITH

RÖNTGEN RAYS

(See Nature, June 4, 1896, p. 109)
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P. J. KIPP & ZONEN (J. W. GILTAY, OPVOLGER),
DELFT, HOLLAND.

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Most carefully prepared; each Screen tested and guaranteed. Th bones of the body can be easily examined, and Photographs taken with one minute's exposure or less through these excellent Screens, with great clearness. A Stereoscopic Dark Box, to fit the Screens, will be ready in a few days, 9*s.* 6*d.* extra.

Address, H. LEES, CASTLETOWN, ISLE OF MAN.

THE ALBION S.S. COMPANY (LIMITED).

FORTNIGHTLY CRUISES from NEWCASTLE-ON-TYNE to NORWAY.

The Finest YACHTING STEAMER afloat. No Upper Berths

"MIDNIGHT SUN," 3178 Tons, 3500 H.P.

Capt. CABORNE, R.N.R., F.R.G.S.

Sailings:—June 6, 20; July 4, 18; August 1 and 15.

Fares from 12 Guineas, including first-class Table.

For Itinerary, &c., apply to "MIDNIGHT SUN" PASSENGER SUPERINTENDENT 4 Lombard Street, Newcastle-on-Tyne.

INDEX NUMBER.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1389, VOL. 54.] THURSDAY, JUNE 11, 1896. [PRICE ONE SHILLING.

Registered as a Newspaper at the General Post Office.]

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

No. 1391, Vol. 54.] THURSDAY, JUNE 25, 1896. [Price Sixpence.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1392, Vol. 54.] THURSDAY, JULY 2, 1896. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1393, VOL. 54] THURSDAY, JULY 9, 1896. [PRICE SIXPENCE.

Registered as a Newspaper at the General Post Office.]

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

No. 1394, VOL. 54] THURSDAY, JULY 16, 1896. [PRICE SIXPENCE.

Registered as a Newspaper at the General Post Office.]

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1395, Vol. 54] THURSDAY, JULY 23, 1896. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

CITY AND GUILDS OF LONDON INSTITUTE.

SESSION 1896-97.

The Courses of Instruction in Engineering and Chemistry at the Institute's Colleges commence in October, and cover a period of two to three years. The Matriculation Examination of the Central Technical College will be held on September 21 to 24, and the Entrance Examination of the Day Department of the Technical College, Finsbury, on September 22.

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(Leonard Street, City Road, E.C.). The DAY DEPARTMENT provides Courses of Intermediate Instruction for Students not under 14 years of age, preparing to enter Mechanical or Electrical Engineering and Chemical Industries.

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Professors:—S. P. Thompson, D.Sc., F.R.S. (Electrical Engineering), R. Meldola, F.R.S. (Chemistry).

JOHN WATNEY, Hon. Secretary.

City and Guilds of London Institute,
Gresham College, Basinghall Street, E.C.

NORTHAMPTON INSTITUTE,

CLERKENWELL, LONDON, E.C.

The Governing Body invite Applications for the following Appointments:—

HEAD of the DEPARTMENT of MECHANICAL ENGINEERING and METAL TRADES. Salary, £250 per Annum.

HEAD of the ARTISTIC CRAFTS DEPARTMENT. Salary, £250 per Annum.

CHIEF ASSISTANT in the DEPARTMENT of APPLIED PHYSICS (including ELECTRICAL ENGINEERING). Salary, £180 per Annum.

HEAD TEACHER in the DOMESTIC ECONOMY SCHOOL. Salary, £100 per Annum.

Two ASSISTANT TEACHERS in the DOMESTIC ECONOMY SCHOOL. Salaries, £80 per Annum each.

All the above Appointments will date from October 1, 1896, but the successful Candidates for the four first-named Appointments will be required in the meantime to advise the Principal with respect to Equipment and Organisation.

Applications for any of the Appointments are to be sent in to the Principal not later than 10 a.m. on Tuesday, July 28, 1896.

The Conditions of Appointment and Forms of Application may be obtained by written Application addressed to the undersigned at the Northampton Institute, St. John Street Road, Clerkenwell, London, E.C.

R. MULLINEUX WALMSLEY, D.Sc., Principal.

HERIOT WATT COLLEGE, EDINBURGH.

F. GRANT OGILVIE, M.A., B.Sc., F.R.S.E., Principal.

DAY CLASSES—SESSION 1896-97.

The Session extends from Tuesday, October 6, 1896, to Friday, June 4, 1897.

These Classes provide courses of study extending over one or more years, suitable for Students who have previously passed through the curriculum of a Secondary School. The principal courses are:—Physical and Chemical, Mechanical Engineering and Electrical Engineering. There are also Classes in French, German, Drawing, and Practice of Commerce. Class Fees, from £1 1s. to £4 4s. Session Fee, £10 10s.

There is also a preparatory course of instruction for Agricultural Students. Session Fee, £5 5s. An extract from the Calendar of the College, giving particulars of the Day Classes, and of the various Appliances, Laboratories, and Workshops available for instruction, may be had on application to the Librarian at the College, or to the Treasurer of George Heriot's Trust.

DAVID LEWIS, Treasurer.

Treasurer's Chambers, 20 York Place, Edinburgh,
July 21, 1896.

The DURHAM COLLEGE of SCIENCE, NEWCASTLE-UPON-TYNE.

The Council invite Applications for the post of Assistant Lecturer and Demonstrator in Physics.

The Stipend attached to the appointment is £120 per annum.

Duties will commence on October 1 next.

Applications and Testimonials must be sent, on or before August 29, to the undersigned, from whom further particulars may be obtained.

H. F. STOCKDALE, Secretary.

OWENS COLLEGE, VICTORIA UNIVERSITY, MANCHESTER.

PROSPECTUSES for the Session 1896-7 will be forwarded on application:—

I.—DEPARTMENT of ARTS, SCIENCE, and LAW; and DEPARTMENT for WOMEN.
II.—DEPARTMENT of MEDICINE.
III.—EVENING and POPULAR COURSES.

Special Prospectuses can also be obtained of—

IV.—DEPARTMENT of ENGINEERING.
V.—DEPARTMENT of LAW.
VI.—DEPARTMENT of PUBLIC HEALTH.
VII.—DENTAL DEPARTMENT.
VIII.—PHARMACEUTICAL DEPARTMENT; and
IX.—A LIST of FELLOWSHIPS, SCHOLARSHIPS, EXHIBITIONS, and PRIZES.

Apply to Mr. Cornish, 16 St. Ann's Square, Manchester; or at the College.

SYDNEY CHAFFERS, Registrar.

UNIVERSITY COLLEGE, LONDON.

The Session of the Faculty of Medicine will commence on October 1. Introductory Lecture, at 4 p.m., by Prof. Sidney Martin, M.D., F.R.S.

The Examinations for the Entrance Exhibitions will commence on September 24.

Scholarships, Exhibitions, and Prizes of the value of £800, are awarded annually.

In University College Hospital about 3000 In-patients, and 35,000 Outpatients, are treated during the year. Thirty-six Appointments, eighteen being resident (as House Surgeon, House Physician, Obstetric Assistant, &c.), are filled up by competition during the year, and these, as well as all Clerkships and Dresserships, are open to Students of the Hospital without extra fee. Resident officers receive free board and lodging.

Prospectuses, with full information as to Classes, Prizes, &c., may be obtained from University College, Gower Street, W.C.

A. E. BARKER, F.R.C.S., Dean.
J. M. HORSBURGH, M.A., Secretary.

UNIVERSITY COLLEGE OF NORTH WALES, BANGOR.

ELECTRICAL ENGINEERING.

Professor ANDREW GRAY, LL.D., F.R.S., will begin, in OCTOBER next, a Systematic COURSE of INSTRUCTION in Electrical Measurement and Practical Electricity. The Physical Laboratory is fully equipped with a Compound Steam Engine, Dynamos, Transformer, Secondary Battery, and the most approved modern Measuring Instruments for all Branches of Electrical Engineering. Laboratory Fees at the rate of £1 1s. per Term for six hours per week. Composition Fee for all College Lectures for the Session, £10.

Applications for Calendar, Prospectus, and general information to be made to

J. E. LLOYD, M.A., Secretary and Registrar.

UNIVERSITY COLLEGE OF NORTH WALES.

(A CONSTITUENT COLLEGE OF THE UNIVERSITY OF WALES.)

Applications are invited for the post of ASSISTANT LECTURER IN AGRICULTURE. Salary £120. Competent knowledge of Forestry desirable, but not essential. Ability to Lecture in Welsh will be considered an additional qualification.

For particulars apply to the undersigned, to whom applications must be sent not later than September 1.

J. E. LLOYD, M.A., Secretary and Registrar.

Bangor, July 1, 1896.

THE ELECTRICAL AND GENERAL ENGINEERING COLLEGE AND SCHOOL OF SCIENCE.

PENYWERN HOUSE, 2 and 4, PENYWERN ROAD, EARL'S COURT, S.W.

Principal—G. W. de TUNZELMANN, B.Sc., M.I.E.E.
Senior-Instructor—C. CAPITO, M.I.E.E., M.I.M.E.

Laboratories, Dynamo Room, Steam Engine, Engineering Workshop with Machine Tools, Pattern Shop, &c.

The College provides a Training for Electrical, Mechanical, Civil, and Mining Engineers, for Science Students in Mathematics, Physics, Chemistry, Biology, Geology, and Mineralogy, and Preliminary Training for Students entering Cooper's Hill and the Central Institution.

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1396, Vol. 54] THURSDAY, JULY 30, 1896. [Price Sixpence.

Registered as a Newspaper at the General Post

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1397, VOL. 54] THURSDAY, AUGUST 6, 1896. [PRICE SIXPENCE.

Registered as a Newspaper at the General Post Office.]

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

No. 1398, Vol. 54] THURSDAY, AUGUST 13, 1896. [PRICE SIXPENCE.

Registered as a Newspaper at the General Post Office.]

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 1399, Vol. 54] THURSDAY, AUGUST 20, 1896. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

NO. 1400, VOL. 54] THURSDAY, AUGUST 27, 1896. [PRICE SIXPENCE

Registered as a Newspaper at the General Post Office.]

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

No. 1401, Vol. 54] THURSDAY, SEPTEMBER 3, 1896. [Price Sixpence.

Registered as a Newspaper at the General Post Office.]

NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

No. 1402, VOL. 54] THURSDAY, SEPTEMBER 10, 1896. [PRICE SIXPENCE.

Registered as a Newspaper at the General Post Office.]

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE,

BURLINGTON HOUSE, LONDON, W.

LIVERPOOL MEETING, SEPTEMBER 16 TO 23.

PRESIDENT-ELECT—

Sir JOSEPH LISTER, Bart., D.C.L., LL.D., President of the Royal Society.

The JOURNAL, PRESIDENT'S ADDRESS, and other Printed Papers issued by the Association during the Annual Meeting, will be forwarded daily, by post, to Members and others unable to attend, on application and prepayment of 2s 6d. to the Clerk of the Association, Mr. H. C. STEWARDSON, Reception Room, Liverpool, on or before the first day of the meeting.

G. GRIFFITH.

UNIVERSITY COLLEGE, LONDON.

The SESSION of the FACULTIES of ARTS and LAWS and of SCIENCE including the Indian and Oriental Schools and the Department of Fine Arts) will begin on OCTOBER 6. The Introductory Lecture will be given, at 3 p.m., by Prof. J. P. POSTGATE, M.A., Litt.D.

SUBJECTS.	PROFESSORS OR TEACHERS.
Latin ...	A. E. HOUSMAN, M.A.
Greek ...	J. A. PLATT, M.A.
Hebrew (Goldsmid Professorship) ...	The Rev. Dr. D. W. MARKS
Comparative Philology ...	J. P. POSTGATE, M.A., Litt.D.
Archæology (Yates Professorship) ...	E. A. GARDNER, M.A.
Egyptian Archæology (Edwards Professorship) ...	W. M. FLINDERS PETRIE, D.C.L., LL.D.
English (Quain Professorship) ...	W. P. KER, M.A.
History ...	F. C. MONTAGUE, M.A.
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